# The Engineer

LONDON, FRIDAY, SEPTEMBER 25, 1942.


## PUBLIC NOTICES

### BLACK SLUICE DRAINAGE BOARD

**Tenders are Invited for the** CONSTRUCTION of a REINFORCED CONCRETE ROAD BOX CULVERT, 8ft. by 8ft. internal dimensions, 54ft. long. Conditions of contract, specification, and bill of quantities can be obtained from the undersigned. Tenders, in sealed envelopes, endorsed "Tender for Culvert," are to be sent to

THE CLERK,
Black Sluice Drainage Board,
16, Wide Bargate,
Boston, Lincs,

not later than Monday, 5th October, 1942.
The Board do not bind themselves to accept the lowest of any Tender. 8803

### MANCHESTER MUNICIPAL COLLEGE OF TECHNOLOGY

(Faculty of Technology in the University of Manchester)

APPOINTMENT OF ASSISTANT LECTURER IN MECHANICAL ENGINEERING

**The Governing Body Invites** APPLICATIONS for an ASSISTANT LECTURESHIP in MECHANICAL ENGINEERING in the College of Technology, with the title and status of Assistant Lecturer in the University of Manchester.

Salary £300 per annum, rising by annual increments of £25 to £400 per annum. Commencing salary according to qualifications.

Conditions of appointment and form of application may be obtained from the Registrar, College of Technology, Manchester, 1. The last date for the receipt of applications is Monday, 5th October.

Canvassing, either directly or indirectly, will disqualify a candidate for appointment.

J. E. MYERS,
8800 Principal of the College.

### GLAMORGAN EDUCATION COMMITTEE

SCHOOL OF MINES AND TECHNOLOGY, TREFOREST

Principal: ROBERT JAMES, Wh.Sc., A.R.C.S., D.I.C., A.M.I. Mech. E.

**Applications are Invited for** the following Full-time TEACHING POST Duties to commence 1st January, 1943.

HEAD of ENGINEERING DEPARTMENT (Mechanical and Electrical). Salary £540, rising to £690. Applicants should possess a good Honours Engineering Degree, with teaching and industrial experience. Preference will be given to candidates with experience in Teaching to Standard of Final B.Sc. Engineering.

Applications forms (and particulars of duties), which must be returned not later than the 12th October, may be obtained by forwarding a stamped, addressed foolscap envelope to the undersigned.

F. E. REES,
Director of Education.
Glamorgan County Hall,
Cardiff. 8806

## SITUATIONS OPEN

COPIES OF TESTIMONIALS, NOT ORIGINALS, UNLESS SPECIFICALLY REQUESTED.

TO ADVERTISERS UNDER BOX NUMBERS IN SITUATIONS OPEN SECTION.

For the benefit of applicants, the Proprietors are prepared to insert brief notices that vacancies are filled, upon receipt of notifications from the Advertisers. These notices (limited to one line) will be free of charge, and co-operation is asked for.

### IMPORTANT

**Advertisers in Situations Open Column should make themselves acquainted with the terms of**

**STATUTORY RULES & ORDERS 1941 No. 2069**

**RESTRICTION ON ENGAGEMENT ORDER**

COST and MATERIAL CONTROL CLERK for Small Engineering Works, W.4 district. Previous experience Oil Engines an advantage. Ineligible military service.—Address, 8788, The Engineer Office. 8788 A

FACTORY SUPERINTENDENT WANTED (Scotland). Modern plant. Exceptional opportunity for engineer with ambition and initiative. Experience in Quantity Production of Medium-size Components essential. Permanent appointment. Superannuation. Replies treated in confidence. Interview expenses paid. Age, experience, and salary.—Address, 8793, The Engineer Office. 8793 A

## The Engineer

### PRINCIPAL CONTENTS OF THIS ISSUE

ARRANGED FOR CARD INDEXING
(TABLE OF CONTENTS, PAGE 258)


Delaware Aqueduct—No. IV (P. 248)
THE ENGINEER, 25 - 9 - 42

Canadian Locomotive Experiences No. IV (P. 250)
(E. H. LIVESAY) THE ENGINEER, 25 - 9 - 42

Sir Charles Parsons and Mechanical Gearing No. II (P. 261)
(S. F. DOREY) THE ENGINEER, 25 - 9 - 42

Plastics in Aircraft Construction—No. II (P. 265)
(G. W. DEBELL) THE ENGINEER, 25 - 9 - 42

Fen Flood Protection—No. III (P. 254)
THE ENGINEER, 25 - 9 - 42

Air Power (P. 259)
(H. E. WIMPERIS) THE ENGINEER, 25 - 9 - 42

Speed and Convoy (P. 258)
THE ENGINEER, 25 - 9 - 42

Merchant Marine (P. 253)
(LORD MOTTISTONE) THE ENGINEER, 25 - 9 - 42



**BABCOCK VALVE VALUE**



***INDEX TO ADVERTISEMENTS, PAGE 57***


## NOTICE

**CORRESPONDENCE *re* Accounts and Remittances should be sent in future to:**

**28, ESSEX STREET, STRAND, LONDON, W.C.2, and NOT to Bath.**

**This change has been caused by enemy action, and co-operation is earnestly asked for.**

## SITUATIONS OPEN

MANAGER REQUIRED, to Develop and Control the Manufacture of Machine Tools and Small Tools. This position demands a high degree of technical knowledge, practical experience, and administrative ability. Only men capable of earning a four-figure salary need apply.—Address, 8796, The Engineer Office. 8796 A

MEN WANTED for Direct Commissions in Army as ENGINEER OFFICERS (ungraded), aged up to 41. Must have served at least three years' apprenticeship with a recognised engineering firm of some standing and held responsible position in Engineering Industry. Engineers with technical qualifications of Higher National Certificate or above should not apply.—Applications, in writing, giving full particulars and name and address of present employer, to W.N., c/o Charles Barker and Sons, Ltd., 31, Budge Row, London, E.C.4. 8807 A

## SITUATIONS OPEN

OVERSEAS EMPLOYMENT.—A GENERAL ENGINEERING ESTABLISHMENT in Ceylon REQUIRES a well-educated and fully practical MECHANICAL and ELECTRICAL ENGINEER, regularly trained with indenture. Candidates should be under 30, unmarried, and of good personality. Technical qualifications essential. Drawing-office experience, knowledge of business side, including estimating, costing, correspondence, and salesmanship, with ability to meet competition and secure orders are necessary. Capacity to train and direct native staff and interview clients, knowledge of book-keeping and records, a distinct advantage.—Written applications (no interviews), giving details of age, training, experience, name of present employers, and salary required, should be sent to the SECRETARY, Overseas Manpower Committee (Ref. 336), Ministry of Labour and National Service, Hanway House, Red Lion Square, London, W.C.1. 8797 A

## SITUATIONS OPEN

GENERAL ENGINEERING WORKS Have a VACANCY for a MANAGER of their Machine, Fitting, and Assembly Shops. Largely contract jobbing work of urgent priority, with a certain amount of batch production. Shops equipped with large modern machine tools and employing 300—male and female.

Applicants must be conversant with latest Machine Shop Practice, including Rate Fixing and Planned Production; preference will be given to those having previous experience in a similar managerial capacity. Permanent situation with good prospects.

Please state particulars of age, experience, and salary required.

Address, 8799, The Engineer Office. 8799 A

ORGANISATION of Engineering Development and Research REQUIRE EXPERT to Take Charge of Research Department for substitutes and to deal with patent questions, &c. Access to laboratory preferred, but not essential. Advertisers are also interested in taking over good laboratory. Full details.—Address, 8798, The Engineer Office. 8798 A

THE Post You are Seeking May Not be Advertised in this Column, but do not lose the Opportunity of Bringing your Requirements before all those who would be interested and could employ you. An Advertisement in the "Situations Wanted" Column would be seen by all Leading Engineering Concerns for the cost of Four Lines, 6s.; 1s. 6d. for each Additional Line. There is no better way of covering so large a field for such a small charge.

WORKS MANAGER REQUIRED for medium sized production factory, Reading. Applicants must be well educated, preferably having served apprenticeship, with good D.O. and workshop training. Must be a good disciplinarian. It is essential that those who apply are able to give a lead in matters of design of tools, apparatus and methods of manufacture. Permanent and progressive post for the right man with good post-War prospects. Write, stating experience and age. Salary suggested £1000/£1500.—Address 8810, The Engineer Office. 8810 A

## SITUATIONS WANTED

A.M.I. MECH. E., M.I. Prod. E., M.I. Loco. E. (48), with first-class technical and administrative abilities, SEEKS CHANGE to more important war work with executive position, preferably in North London. Sound knowledge and wide experience in design, development and standardisation of heavy and light machines, precision mechanisms, production statistics of mass assemblies and specifications of Govt. Depts., consulting engineers, &c.—Address, P4392, The Engineer Office. P4392 B

A.R.P. CONTROL OFFICER, Disengaged end September; at present occupying this position with large engineering firm in North, employing 3000; certified raid spotter and bomb disposal instructor. Exceptional organising and executive experience. DESIRES similar POSITION.—Address, P4375, The Engineer Office. P4375 B

RESEARCH.—Fully-qualified MECHANICAL ENGINEER, specialising in design, construction, and operation of research instruments, apparatus, DESIRES POST in London.—Address, P4367, The Engineer Office. P4367 B


For continuation of Small Advertisements see page 2.

**SITUATIONS WANTED (continued) Page 2**

**AUCTIONEERS & VALUERS, Page 58**

**FOR SALE, Pages 2 and 58**

**MACHINERY, &c., WANTED, Page 2**

**PARTNERSHIPS, Page 2**

**SUB-CONTRACTING, Page 2**

**PATENTS, Page 2**

**EDUCATIONAL, Page 2**

*For Advertisement Rates see First Column Overleaf*


**CLASSIFIED ADVERTISEMENTS CLOSE FOR**

**PRESS-NOON WEDNESDAYS**

# The Engineer

## Annual Subscription Rates

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| CANADA ... ... ... ... | £2 | 18 | 6 |
| ABROAD... ... ... ... ... | £3 | 3 | 0 |

(except Canada)

**ADVERTISEMENTS**

**The Charges for Classified Advertisements are 1/6 per line up to one inch—minimum charge, 6/-; those occupying one inch or more at the rate of 18/- per inch. Box numbers, 1/- extra, except in the case of advertisements under "Situations Wanted." Orders MUST be accompanied by a remittance. The rates for Displayed Advertisements will be forwarded on application. Classified Advertisements cannot be inserted unless delivered before TWO o'clock on Wednesday afternoon.**

*Letters relating to the Advertisement and the Publishing Departments of the Paper are to be addressed to the Publisher; all other letters are to be addressed to the Editor of* THE ENGINEER.

**Postal Address,**
**28, Essex Street, Strand, London, W.C.2.**

**Teleg. Address,**
**"Engineer Newspaper, Estrand, London."**
**Tel., Central 6565 (10 lines).**


## SITUATIONS WANTED

CHARTERED CIVIL ENGINEER (Over Age), with extensive business experience, administration, management, negotiation, distribution, sales, &c., SEEKS PART or WHOLE-TIME EMPLOYMENT. Could manage London office, assist managing director, or replace director called up.—Address, 8804, The Engineer Office. 8804 B

CIVIL ENGINEER, Age 28. Exempt from military service, shortly free. University degree and professional qualifications. Varied experience of drawing-office and outdoor work on large engineering projects.—Address, P4395, The Engineer Office. P4395 B

COLD-ROLLED STRIP STEEL.—MANAGER, 12½ years, SEEKS SITUATION for October 1st. Old or modern plant. Guaranteed increase where production lagging. Around 300 tons per week preferred. References excellent.—Address, P4386, The Engineer Office. P4386 B

EFFICIENT SECRETARY/STENOGRAPHER DESIRES RESPONSIBLE POSITION. Good salary.—Address, P4383, The Engineer Office. P4383 B

ENGINEER, Age 37, SEEKS WORK of greater national importance. Very keen and energetic, experienced in modern production methods and use of unskilled female labour.—Address, P4385, The Engineer Office. P4385 B

ENGINEER, B.Sc. in Mechanical Engineering (Glasgow University), SEEKS POST with firm engaged in the manufacture of mechanical draught equipment, dust collectors, and auxiliary equipment for power station and/or industrial boilers. Six years' experience in such work, drawing-office, research and estimating departments. Would prefer to stay in London area. £420 p.a.—Address, P4394, The Engineer Office. P4394 B

ENGINEER with wide experience in design, mining, crushing, industrial installations, supervising erections, estimating, good Draughtsman; London district preferred. £450: part time considered.—Address, P4388, The Engineer Office. P4388 B

GENERAL ENG. (36) SEEKS HIGHER POSITION; 7 years' app., insp. and supervision, specialised work mass prod. methods, prec. limits, and light planning. Present salary £500.—Address, P4382, The Engineer Office. P4382 B

GENERAL MANAGER, Fully Experienced, commercial, sales, highest technical qualifications, complete knowledge engineering steel works, foundry, ferrous and non-ferrous trades, also light alloys, production planning, and tooling, present salary four figures, Age 44, OPEN for RE-ENGAGEMENT.—Address, P4380, The Engineer Office. P4380 B

IF the Man You Are Seeking is Not Amongst those Advertising in this Column, a Small Announcement in the "Situations Open" Column will Quickly and Economically Produce the Right Selection of Applicants, at the same time Eliminating Waste of Effort, Waste of Time, and Waste of Opportunity. The charge is Four Lines or under, 6s.; each Additional Line, 1s. 6d. Box Numbers, 1s. extra, which includes despatch of all replies.

INLAND WATERWAYS AND DOCKS.—CIVIL ENGINEER, age 33, B.Sc. (Eng.), 1st Class Honours, A.M. Inst. C.E., varied experience design, construction, and maintenance, specialist in organisation of maintenance and staff administration, commercial experience, AVAILABLE DECEMBER.—Address, P4393, The Engineer Office. P4393 B

MAINTENANCE ENGINEER, Steam, Electric, Refrigerating; 15 years marine seagoing chief engineer; age 58. Salary £300-350. Any district.—Address, P4378, The Engineer Office. P4378 B

PLANT and MAINTENANCE ENGINEER, age 38, 12 years' supervisory experience, all branches; free end September. Excellent refs. £700/800 p.a.—Address, P4374, The Engineer Office. P4374 B

## SITUATIONS WANTED

STORES MANAGER, Disengaged Oct. 10th, will CONSIDER POSITION anywhere in the British Isles. Age 34. Salary according to responsibility.—Address, P4384, The Engineer Office. P4384 B

STORES (Bonded or General) and Purchasing Organising. SPECIALIST, shortly free to accept ENGAGEMENT. Methods "regarded as 100 per cent." and "unreservedly accepted" by A.M., M.A.P., and A.I.D.—Address, 8809, The Engineer Office. 8809 B

## PARTNERSHIPS

DISSOLUTION of PARTNERSHIP Frees Advertiser with two new Capstans, Driller, small Centre Lathe, valuable contracts and connections. PROPOSITIONS SOUGHT. Ideal opportunity for practical man to extend existing business.—Address, P4379, The Engineer Office. P4379 C

## MACHINERY, &c., WANTED

WANTED, by a Municipality in South Yorkshire, Hand-operated DERRICK CRANE, capacity 1 ton; Hand-operated TRAVELLING PIPE LAYING GANTRY or similar, capacity 2 to 3 tons; MOBILE CRANE on Road Wheels or Track, capacity 1 to 3 tons.—Address, 8802, The Engineer Office. 8802 F

WANTED, SET of ROLLS, About 7ft. by ¾in., cap. ½, for plate bending. Particulars.—Address, 8808, The Engineer Office. 8808 F

WANTED, a NUMBER of TEE-SLOTTED BED-PLATES or MACHINE TABLES.—THOMAS MITCHELL and SONS, Limited, Bolton. P4376 F

WANTED, TWO Electric or Petrol-driven Lister AUTO. TRUCKS or other good make.—Address, 8775, The Engineer Office. 8775 F

ALFRED HERBERT, Ltd., Coventry, PAY BEST PRICES FOR SECOND-HAND MACHINE TOOLS in good condition by first-class makers.
Write, wire, or 'phone, and our representative will call.
'Phone: 88781 (12 lines), Coventry; Telegrams: "Lathe, Coventry." 1002 F

ALL CLASSES of MACHINE TOOLS WANTED, cash paid.—NORMAN POTTS, 105, Alcester Road South, King's Heath, Birmingham, 14. 8765 F

**We are licensed by the Machine Tool Control for the purchase of all classes of Machine Tools, and we offer good prices for surplus Machinery in any quantities, large or small.**

**F. J. EDWARDS, LTD.**
**359, EUSTON ROAD, LONDON, N.W.1**
**Telephone No.: EUSton 4681**
**Telegrams: "Bescotools, Norwest, London."**

## SUB-CONTRACTING

### WANTED

ADVERTISER will EXECUTE FACTORY "LAY-OUTS," EXTENSIONS, ALTERATIONS and COMPLETE INSTALLATIONS if interested firms will communicate.—Address, P4365, The Engineer Office. P4365 MW

BIRMINGHAM JEWELLERS, Converted to war work, have large capacity for HARD SOLDERING, LIGHT ASSEMBLY WORK, &c.—Inquire A. HILL and CO., 41, Frederick Street, Birmingham, 1. 'Phone, Central 5647. London Firms inquire A. HILL and CO., Liberty House, 222, Regent Street, London, W.1. 8792 MW

EXPERIENCED Draughtsman REQUIRES WORK in mechanical designing, calculations, drawings prepared from rough sketches.—126, Woodbines Ave., Kingston-on-Thames. P4389 MW

LIGHT PRESSINGS and STAMPINGS WANTED in all metals; 20-Ton presses.—COMMERCIAL STRUCTURES, Ltd., Staffa Road, Leyton, E.10. 8774 MW

MACHINING WORK REQUIRED, Large or small lots, suitable for Centre Lathes (9in. ors. by 8ft.), Slotters, Drills, Shapers, Planers, &c.—STRINGERS, Ltd., Wincobank, Sheffield. 8084 MW

POWER and HAND FORGING WORK WANTED, up to 3in. sq.—COMMERCIAL STRUCTURES, Ltd., Staffa Road, Leyton, E.10. 8772 MW

PRECISION TUBE and BAR BENDING WORK WANTED.—COMMERCIAL STRUCTURES, Ltd., Staffa Road, Leyton, E.10. 8773 MW

PROFILING WORK WANTED.—COMMERCIAL STRUCTURES, Ltd., Staffa Road, Leyton. E.10. 8771 MW

SEVEN DRAUGHTSMEN (Mech. and Jig and Tool) DESIRE SPARE-TIME CONTRACTS. Tracing, design.—Address, P4391, The Engineer Office. P4391 MW

## PATENTS

THE PROPRIETORS of BRITISH PATENT No. 431,777, relating to "Improvements relating to Carbon Iron Alloys," DESIRE to ENTER into NEGOTIATIONS with one or more firms in Great Britain for the SALE of the PATENT RIGHTS or for the GRANT of LICENCES to manufacture under royalty.—Inquiries to be addressed to D. YOUNG and CO., Chartered Patent Agents, 21, Bourne End Road, Northwood, Middlesex. 8763 H

## FOR SALE

FOR SALE

### ELECTRIC GENERATING SETS

1100-kW UNUSED TURBO-ALTERNATOR, by A.E.G., with surface condenser; 0.8 p.f., 525 v., 3-ph., 50 cy.; pressure 170 lb.; 500 deg. F.; 3000 r.p.m.

1000-kW TURBO-ALTERNATOR, by English Electric, with surface condenser; 6600 v., 3-ph., 50 cy.; pressure 250 lb.; 600 deg. F., 3000 r.p.m.

500-kW TURBO-ALTERNATOR, by Peter Brotherhood; 200 lb. per sq. in. at 600 deg. F.; 10 lb. back pressure; 4000 r.p.m.; Reduction Gear, by David Brown, to 750 r.p.m.; Alternator, by Mather and Platt, 6000/6600 v., 3-ph., 50 cy.; 0.8 p.f.

500-kW TURBO-ALTERNATOR, by B.T.H.; pressure 190 lb.; condensing plant, by Cole, Marchant and Morley; condenser auxiliaries, air pump, extraction pump, circulating pump; turbine coupled to alternator, by B.T.H.; 625 kVA, 0.8 p.f.; 6600 v., 3-ph., 50 cy.; 3000 r.p.m.

400-kW STEAM-DRIVEN ALTERNATOR, comprising vertical compound Steam Engine, by Belliss and Morcom; pressure 110/140 lb.; speed 375 r.p.m.; with condensing plant; direct driving alternator, by E.C.C.; 415/3300 v., 3-ph., 50 cy., and direct-coupled exciter.

TWO 313-kVA STEAM-DRIVEN ALTERNATORS, each comprising vertical compound Steam Engine, by Belliss and Morcom; pressure 150 lb.; speed 375 r.p.m.; direct-coupled alternator, by E.E.C.; 500/550 v., 3-ph., 50 cy.; 0.8 p.f.; direct-coupled exciter.

TWO 250-kW STEAM-DRIVEN GENERATORS, each comprising twin-cylinder Steam Engine, by Browett-Lindley; pressure 150 lb.; electric fly-wheels driving generator, by E.C.C.; 255 v., D.C., 350 r.p.m.

250-kVA STEAM-DRIVEN ALTERNATOR, comprising Steam Engine, by Belliss and Morcom; pressure 100 lb.; Alternator, by B.T.H.; 2300 v., 3-ph., 50 cy., 333 r.p.m.; Kinetic Jet Condenser.

250-kW STEAM-DRIVEN ALTERNATOR, comprising vertical compound enclosed Steam Engine, by Belliss and Morcom; pressure 150 lb.; electric fly-wheel; direct coupled to Alternator, by E.E.C.; 500/550 v., 3-ph., 50 cy.; 375 r.p.m.

**GEORGE COHEN, SONS**
& CO., LTD.,
WOOD LANE, LONDON, W.12.
and STANNINGLEY, nr. LEEDS.

FOR DISPOSAL, Good SECOND-HAND LANCASHIRE BOILER STORAGE TANK, which is approximately 30ft. long by about 8ft. diameter, having an approximate capacity of 9400 gallons.—STANLEY ENGINEERING CO., Bath (telephone, 4294; telegrams, "Trius"). 8702 G

FOR DISPOSAL, ONE Good SECOND-HAND LANCASHIRE BOILER, by E. Danks and Co., Ltd., which is approximately 30ft. by about 8ft. 6in. diameter, suitable for 100 lb. working pressure. Chimney or feed pump not included. Made about 1925.
STANLEY ENGINEERING CO., Bath. Telephone, 4294; telegrams, "Trius." 8724 G

FOR DISPOSAL, ONE "PLUROVANE" ALL STAINLESS STEEL HIGH-LIFT TURBINE PUMP, by Mather and Platt, Ltd., 600 g.p.m. at 1090ft. head, 7in. suction and 6in. delivery. Direct coupled to a 280 H.P. SLIPRING MOTOR, 400/440 volts, 3-phase, 50 cycles, 1500 r.p.m. Complete with "Ellison" control gear. In very good second-hand condition.
STANLEY ENGINEERING CO., Bath. Telephone, 4294; telegrams, "Trius." 8731 G

FOR SALE, ROBEY HORIZONTAL COMPOUND STEAM ENGINE. Cylinders 10½in. by 18in. by 18in. stroke, 150 lb. W.P., makers No. 23197. In first-class working order.—CANTERBURY GAS & WATER CO., Waterworks Dept., Wincheap, Canterbury. P4387 G

FOR SALE, HORIZONTAL WATER-COOLED AIR COMPRESSOR, by Consolidated, 550 cu. ft. per minute to 100 lb. per sq. in. Complete with 125 H.P. MOTOR and STARTER for 400-volt, 50 cycle, 3-phase. Belt drive and vertical air receiver.—Write, CHARLES ROBERTS and CO., Ltd., Horbury Junction, near Wakefield. P4390 G

FOR SALE, ONE 75 B.H.P. at 180 r.p.m. National GAS ENGINE and 100 H.P. Crossley SUCTION GAS PRODUCING PLANT. Very little used since 1936, when a new liner and piston were fitted. Can be seen by appointment.—Apply, THE COLCHESTER LATHE COMPANY, Ltd., Hythe, Colchester. 8762 G

FOR SALE, THEODOLITES.
DRAWING INSTRUMENTS, SECOND-HAND
CLARKSONS, 338, High Holborn, W.C.1.
(Opposite Gray's Inn Road.)

FOR SALE, LEVELS.
DRAWING INSTRUMENTS, SECOND-HAND
CLARKSONS, 338, High Holborn, W.C.1.
(Opposite Gray's Inn Road.) Ex

FOR SALE, IRON CORRUGATING MACHINE. Address for particulars, P4377, The Engineer Office. P4377 G

## EDUCATIONAL


**AUTHORITATIVE CORRESPONDENCE TRAINING**

25 FIRST PLACES

and HUNDREDS OF PASSES in the A.M. Inst. C.E., A.M.I. Mech. E., A.M.I. E.E., A.F.R.Ae.S., A.M.I. Chem. E., C. & G., etc., Examinations have been gained by T.I.G.B. Students.

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THE TECHNOLOGICAL INSTITUTE OF GREAT BRITAIN
76, TEMPLE BAR HOUSE, LONDON, E.C.4.


For continuation of Small Advertisements see page 58.


**STUART Centrifugal ELECTRIC PUMP** IS IDEAL FOR MACHINE TOOL COOLING AND AS SUDS PUMP

No. 10. 100 galls. p.h. £5 2s. 6d.
No. 11. 280 galls. p.h. £6 6s. 0d.
Carriage and package 2s. extra. From stock
State voltage. Send 2½d. stamp for full specification
L.R. SUPPLY CO. LTD. (Dept. E.R.),
"Winden," Ardingly Road, Balcombe, Sussex

**JOSEPH Adamson**
*& Company Ltd.*
*Presswork · Cranes · Boilers*
P.O. BOX 4, HYDE, Ches.

**THE standardised card advertisements below are inserted in place of the firms' large advertisements which have been omitted due to the paper shortage**

**EDGAR ALLEN & CO. LTD.**
IMPERIAL STEEL WORKS, SHEFFIELD, 9
See our displayed advertisement
AUGUST 28

**BROADWAY ENGINEERING COMPANY LIMITED**
Carlisle Road, Hendon, London, N.W.9
See our displayed advertisement
AUGUST 28

**BURTON GRIFFITHS & CO. Ltd.**
SPARKBROOK, BIRMINGHAM
See our displayed advertisement
SEPTEMBER 11

**NATIONAL GAS & OIL ENGINE Co. Ltd.**
Ashton-under-Lyne, Lancashire
See our displayed advertisement
AUGUST 28

**SIEMENS-SCHUCKERT (GREAT BRITAIN) LIMITED**
GREAT WEST RD., BRENTFORD, MIDDX.
See our displayed advertisement
AUGUST 28

**The Standard Piston Ring and Engineering Co. Ltd.**
DON ROAD, SHEFFIELD
See our displayed advertisement
SEPTEMBER 11

**JAMES WALKER CO. LTD.**
"LION" WORKS, WOKING, SURREY
See our displayed advertisement
SEPTEMBER 11

# A Seven-Day Journal

## Lost Warships Replaced

SPEAKING at Sheffield, on Sunday last, September 20th, Mr. A. V. Alexander, the First Lord of the Admiralty, announced that all the capital ships, aircraft carriers, and cruisers of the Royal Navy which had been lost in the last two and a-quarter years had now been replaced. We had also lost, Mr. Alexander said, a considerable number of destroyers, which had now been more than replaced. We had seen grow up a fleet of corvettes, to which the Dominion of Canada had made a substantial contribution, and we now had also many hundreds of landing craft. All this had been done in face of a series of tasks which people seemed to leave out of account. We were now producing in this country aircraft, tanks, ammunition, ships, and, above all, in ship repairing, a larger output per man of the population than any country in the world. If Britain saved herself by her exertions and the world by her example, it would also be found when the history of the war was written that in the days of deepest disaster the Royal Navy had once more saved the situation. That could be said, Mr. Alexander continued, without withholding praise from the men who fought and won the Battle of Britain. We had seen the strength of the British Navy grow and grow to an extent which people would never think possible. As to the second front, Mr. Alexander asked those who were demanding it to let those in authority be the judges of what should be done and at what moment. The naval losses referred to above, which have all occurred since the fall of France two and a-quarter years ago, when Mr. Churchill's Government took office and Mr. Alexander was appointed First Lord of the Admiralty, include the following ships :—Two battleships, "Barham" and "Prince of Wales"; two battle-cruisers, "Hood" and "Repulse"; four aircraft carriers, "Ark Royal," "Glorious," "Eagle" and "Hermes"; and twenty-two cruisers, "Bonaventure," "Cairo," "Calcutta," "Calypso," "Canberra," "Cornwall," "Dorsetshire," "Dunedin," "Edinburgh," "Exeter," "Fiji," "Galatea," "Gloucester," "Hermione," "Manchester," "Naiad," "Neptune," "Perth," "Southampton," "Sydney," "Trinidad," and "York." Three of these cruisers, "Canberra," "Perth," and "Sydney," all belonged to the Royal Australian Navy.

## Fuel Savings in Industry

REPORTS which are being received by the Fuel Efficiency Committee of the Ministry of Fuel and Power bear witness to the efforts which are being made by industrial firms to secure even greater efficiency in the use of fuel. Further efforts in this direction are now being made by the Ministry's Regional Fuel Efficiency Committees, which consist of panels of qualified fuel engineers. These Committees are visiting factories throughout the country and are advising how further fuel economies can be planned and realised. In one industrial region, visited by engineers since the middle of June last, there are seventy firms with individual fuel consumptions of over 2500 tons a year. In the case of the first thirty firms visited it was found that, without having to make any major alterations to the power plants, it was possible to save 72,000 tons a year out of a total consumption of 775,000 tons. This indicates that it is probable that industry in general can achieve a fuel saving of about 10 per cent. This figure was realised by a county borough, which has reduced its boiler coal consumption from 3000 tons for the June quarter of last year to 2700 tons for the same quarter this year. In the case of one large firm, which has always taken the keenest interest in fuel economy, the expenditure of £13,750 on new plant has brought about a fuel saving of 9000 tons of coal per year. In the case of a group of hotels owned and managed by a railway company the saving is 21 per cent. for the winter coal consumption, while in one of its locomotive works the company has reduced the consumption of process steam by one-third. In another works the engineer noted that the works doors were often left open in cold weather. The proper closing of the doors saved 16 tons of coal per week. A firm using from 500 to 650 tons of coal each week, mostly for heating purposes, was able to achieve considerable fuel savings by appointing men to adjust the heating circuits and to vary the heaters in accordance with outside temperatures. In the iron and steel industries the Research Council of the Iron and Steel Industries reports considerable economies, mostly of the order of 10 per cent., which have been made possible by the appointment of fuel officers at the works who are to be definitely responsible for fuel control.

## The Replacement of Lost Shipping

IN reply to an interview with Mr. Arthur Greenwood, Mr. James Griffiths and Mr. E. Shinwell, arranged with the Administrative Committee of the Parliamentary Labour Party, Lord Leathers, the Minister of War Transport, has confirmed to Mr. Greenwood by letter that the White Paper on the replacement of shipping tonnage, issued by the Government in May last, in no way prejudices the organisation of the shipping industry after the war. That question, states Lord Leathers, will, of course, be settled by Parliament when the time comes, and nothing in the White Paper will in any way hamper the full freedom of Parliament to make the decisions which it thinks right. Another question discussed at the interview was that of post-war conditions for the officers and men of the merchant navy. Lord Leathers says that he is pleased to confirm that he has been for some time in contact with the officers' associations and the seamen's trade unions on this matter, and that he has invited them, with their colleagues in the National Maritime Board, to draw up proposals on certain aspects of this important subject. Further, he will, of course, be happy to see the representatives of the officers and seamen whenever they may think it useful to have a further personal discussion on any aspect of post-war policy. He recalls that, some time ago, he gave an assurance that the policy of His Majesty's Government was that "after the war the British mercantile marine shall be maintained in an adequate state of strength, and in a position of full efficiency, in which term he included the best attainable conditions of employment for the officers and men who are serving the country so well."

## Codes of Practice Committee

THE Minister of Works and Planning has now completed his arrangements for the Committee established to co-ordinate technical practice in the different branches of civil engineering, public works, and building. The Committee, which is called the Codes of Practice Committee, will deal with post-war as well as wartime activities. Its object will be to direct the preparation of codes setting out how all materials can best be applied to the task in hand. These codes will be codes of good practice, aiming at increased efficiency in constructional and other work, and at economy in labour and material. The Committee will have no power to lay down obligatory requirements of any kind. The full name of the Committee, established in collaboration with the Ministry of Health after prolonged discussions with the various interests, is the Committee for Codes of Practice in Civil Engineering, Public Works, and Building. The Committee is composed of representatives of the principal technical institutions, the building research departments of Government, the British Standards Institution, and the Building Industries National Council. These bodies, having reached complete agreement on the principles involved, have nominated the following permanent representatives :—Royal Institution of British Architects, Hubert M. Fairweather and E. Berry Webber; Institution of Civil Engineers, Lieut.-Colonel C. M. Norrie and H. J. F. Gourley; Institution of Electrical Engineers, J. R. Beard and P. V. Hunter, C.B.E.; Institution of Mechanical Engineers, Colonel S. J. Thompson and Dr. H. L. Guy, F.R.S.; Institution of Municipal and County Engineers, E. J. Elford and J. H. Melville-Richards; Institution of Structural Engineers, P. J. Black and G. B. R. Pimm; Incorporated Association of Architects and Surveyors, E. W. Mackenzie and J. E. Swindlehurst; Building Industries National Council, R. Coppock and Major V. Lefebure; British Standards Institution, C. le Maistre and P. Good. In addition, the Ministry of Health, the Ministry of Home Security, the Ministry of Works and Planning, and the Building Research Station will have assessor members. The terms of reference of the Committee are :—To direct the preparation of codes of practice for civil engineering, public works, building, and constructional work.

## Production of New Tanks

IN the course of a speech made in Cardiff, on Saturday last, September 19th, Sir James Grigg, the Secretary of State for War, made reference to new designs of tanks which were now coming into production. In his opinion, Sir James stated, these tanks were miles better than anything which had been provided before, and he was quite certain that the latest tank was a better tank than any other in the world. The effect of this new type of armoured fighting vehicle on the future of the war was, he said, incalculable. He said that he was quite sure that when our soldiers went into battle with this tank they would at last feel that they were properly equipped to cope with any enemy that might appear. In the end, Sir James pointed out, the last battle would be won by the Army. The last blow would be struck by the Army, and unless the workers in the tank factories helped to provide these necessary fighting vehicles for the Army, then that blow would be longer in coming. In his speech Sir James appealed to the workers to put every ounce of strength into the war effort. Workers, he said, should not weaken their war effort by complaining about grievances, even if those grievances were real ones. On the other hand, they should be ready for any sacrifice that might be necessary in order to enable this country to survive.

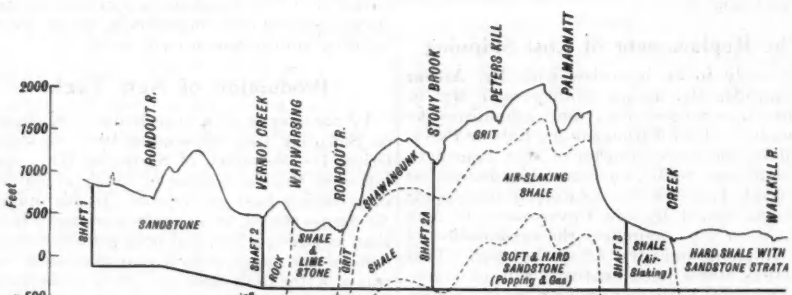
## Loss of the Submarine H.M.S. "Urge"

ON Monday, September 21st, the Board of Admiralty announced that H.M. submarine "Urge" is overdue and must be considered lost. Under the command of Lieut.-Commander E. P. Tomkinson, D.S.O., R.N., the submarine has inflicted particularly heavy losses upon the enemy in the Mediterranean Sea. She torpedoed and sank two 8in. gun cruisers and a destroyer, and also damaged an armed merchant cruiser. Her excellent work levied a heavy toll on the enemy's military supplies and reinforcements. She sank a large transport of the "Duilio" class of about 23,000 tons and a 9000-ton transport vessel, and also three supply ships of medium tonnage and two large oil tankers, besides damaging another medium-sized supply ship. Nearly all of these attacks were carried out against ships and convoys which were heavily screened and protected by aircraft as well as surface craft. One heavily laden tanker and the 9000-ton troopship were sunk by the "Urge" out of one convoy, which consisted of the troopship, two tankers, and a medium-sized supply ship. In attacking these vessels the "Urge" fired her torpedoes from a position within 300 yards of one of the enemy destroyers which was escorting the convoy. The fine example of the "Urge" will, like that of her sister submarine, the "Upholder," the loss of which was recorded in a Journal note of August 28th, be long remembered. The "Urge" was a submarine of the "Ursula" class, having a displacement of 540/730 tons. She carried a ship's complement of twenty-seven, and the following were her principal dimensions and machinery particulars :—180ft. by 16ft. by 12ft. 9in.; armament, six 21in. torpedo tubes and one 3in. gun; machinery, designed output, 615/825 B.H.P., corresponding to speeds of 11·5/10 knots.

# Delaware Aqueduct

No. IV—(*Continued from page 228, September 18th*)

OF the 44·6 miles of tunnel in the Rondout-West Branch section of the 85 miles of rock-driven pressure tunnel between Rondout reservoir in the Catskill Mountains and Hill View reservoir, just outside the northern boundary of the City of New York, 75,157ft. of tunnel driving and lining is called for in a contract awarded to Samuel R. Rosoff, Ltd., on February 20th, 1939, on the basis of the low bid of 18,916,650 dollars.




PROFILE OF TUNNEL—MERRIMAN DAM TO WALKILL RIVER

Besides being by far the longest unit section under a single contract for the Delaware aqueduct, the job is of more than ordinary interest because of the numerous difficulties encountered and mastered during the tunnel driving operations. The contract allowed Samuel R. Rosoff, Ltd., four years in which to do the excavating alone; and, notwithstanding the serious handicaps imposed by the ground conditions, the entire length of more than 75,000 linear feet was completed within a calendar period of only two years and two months, even though operations for a few hundred feet required a whole year's time to win through.

The contract starts where the tunnelling eastward from Shaft 1 of the Merriman dam contract ends—that is, in the Rondout Valley, descending on a 2·31 per cent. gradient for 12,000ft., where it levels out at 400ft. below sea level to pass beneath Shawangunk Mountain and continues onward to the terminal point of the contract well eastward of that mountain in the valley of the Wallkill River. The tunnel is lined with concrete and has a finished inside diameter of 13·5ft., To drive 14·23 miles of tunnel, the Board of Water Supply of the City of New York, under a prior contract, had sunk three access shafts situated about 5 miles apart successively. The westernmost shaft, *i.e.*, Shaft 2, is in the Rondout Valley, close to Vernooy Creek and at the western slope of the Shawangunk range. Shaft 2A was sunk from a valley high on the west side of that range; and Shaft 3 is on the east slope and near the foot of the same range. Shaft 2 was sunk to a depth of 825ft. to intercept the tunnel line; Shaft 2A was sunk to a depth of 1551ft., and is the deepest shaft on the Delaware aqueduct; and Shaft 3 was sunk to a depth of 840ft. Sufficient time elapsed between the sinking and the lining of the shafts to permit seepage to fill them up to the level of ground water; and in the case of Shaft 2A the water mounted to within 35ft. of the shaft collar. The shafts had to be unwatered by Samuel R. Rosoff, Ltd., before tunnel driving could be started, and this work was done in each shaft by mounting two motor pumps on a steel float. These electrically driven pumps were capable of lifting 100 gallons per minute at a maximum head of 520ft. each, and when the float settled deep enough the pumps delivered successively to two other pumps of like kind and capacity mounted in a recess in the shaft lining, and the latter pumps acted as boosters to lift the water to the surface. For Shaft 2A booster pumps were placed in service at three different levels.

Common to all similar contracts on the Delaware aqueduct, each access shaft under Contract 313 had a surface plant consisting of a large hoist to operate the cages and skips running to and from a towering head frame, the cages and the 7-yard skips being counterbalanced; a compressor plant, a ventilating blower plant, a concrete mixing plant, a change house for workmen, a blacksmith shop, also containing facilities for shanking and sharpening drill steels, a storehouse, and a local administrative office. Each shaft was fitted with safety ladders and platforms, and the ventilating ducts were carried down outside the lining, while within the lining were ten galvanised steel pipes, ranging from 1in. to 6in. in diameter, which were used, variously, to handle tunnel drainage, to transmit feed water, to carry compressed air for different underground uses, electric power cables, and telephone and other signal circuits. Adjacent to the bottom of each shaft were a battery of centrifugal pumps, the number depending upon local conditions, rotary car dumpers for emptying muck cars into the loading bins in a pit for the hoist skips, below the floor of the tunnel; transformers, &c., to provide operating current for lighting and power purposes at different voltages.

Apart from its unusual length, this section of tunnel driving presented an exceptional ventilation problem because of the recurrent tapping of methane gas at the headings driven north and south from Shaft 2A especially; rock conditions in some sections that gave a great deal of trouble; and the striking of water-bearing rock that could be traversed only by recourse to a protracted struggle and the adoption of novel means of holding it in check and finally bringing the inflow under complete control. The general nature of the rock pierced can be comperhended when it is said that steel roof support had to be installed throughout nearly 90 per cent. of the total length of the more than 75,000ft. of tunnel driven under Contract 313. This necessitated the excavating of a larger cross section, and in that part of the tunnel where water gave the greatest trouble the excavated section for 750ft. had a diameter of 24ft. to accommodate a steel interlining, reinforced concrete lining on the outside, and the regular inside concrete lining of the 13·5ft. conduit.

## Ventilation Problem

When Shaft 2A had been sunk to the tunnel line in 1938, and the contractor for that work was engaged in driving the required short length of stub tunnel northward from the bottom of the shaft, the drills released methane gas from the rock on August 23rd of that year, and an explosion quickly followed that burned eighteen men at the heading and gravely injured one of them. The presence of the gas had not been foreseen, and the U.S. Bureau of Mines promptly reported upon the situation and outlined precautionary measures that should be taken to prevent a recurrence of explosions. To safeguard the workers it was stated that the ventilating installation should be such as would quickly diffuse any liberated gas and ensure that not more than 0·25 per cent. of methane should be present in the tunnel atmosphere, and even a lower percentage, if possible. It was also recommended that all electrical apparatus should be of the "per-

DRILL CARRIAGE

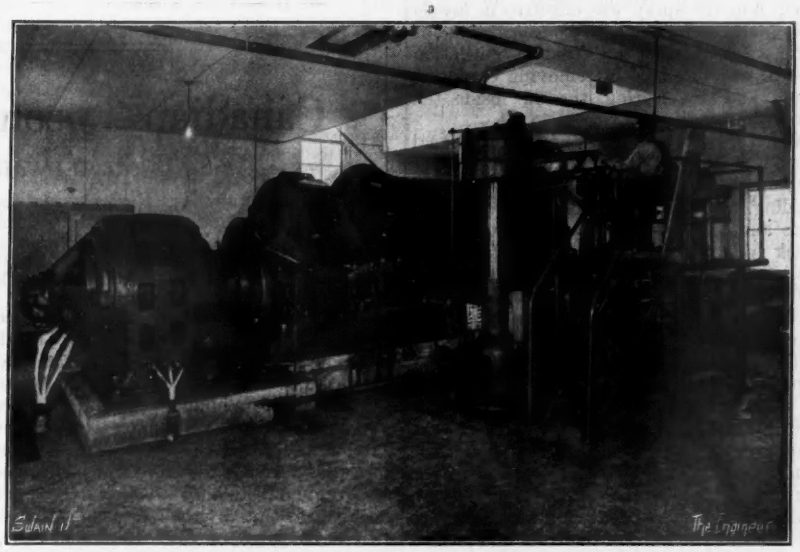
missible type," and that bare flames and sparks should be guarded against. Such were the conditions confronting Samuel R. Rosoff, Ltd., when taking up work under Contract 313.

Tunnel driving had scarcely more than started at the north and south headings from Shaft 2A before the contractor tapped sources of methane gas, and the same gas was released from the rock at the heading north from Shaft 3 not long afterwards. To provide ample ventilation entailed not only blower plants of large capacities, but a complete reversal of the method prevailing elsewhere in ventilating tunnel sections of the Delaware aqueduct. That is to say, instead of blowing fresh air into the tunnel sections at the headings, Samuel R. Rosoff, Ltd., substituted an exhaust system, the intake ends of the vent pipes being placed right at the rock face of a heading where they could pick up immediately any gas issuing from the drill holes as the drilling was being done.

At Shaft 2A the surface blower plant, like similar plants at the two other shafts, has been made up of two 11,330 cubic feet per minute motor blowers. When the north heading from that shaft had advanced about 2 miles an unusually large volume of methane gas escaped into the tunnel. To be prepared for a repetition of such an inflow and to make the ventilating system still more effective, the contractor moved one of the 11,330 cubic feet per minute blowers from the surface and placed it down in the tunnel, setting it up about 12,000ft. in from Shaft 2A. That blower supplemented the action of an 8000 cubic feet per minute Roto-Clone fan mounted on the drill carriage. The Roto-Clone fan was provided with two steel suction intakes, each 8in. by 5ft. in cross section, with one intake at the top and the other one near the bottom of the drill carriage and at about 3ft. from the face. This fan was installed to deal immediately with any methane gas escaping from the rock face and to transmit the gas through a 16in. collapsible vent tube to the intake end of the 28in. main vent pipe, situated approximately 80ft. back from the face. Although methane gas was encountered subsequently in the north and south headings from Shaft 2A and the north heading from Shaft 3, explosive mixtures did not develop because of the effectiveness of the ventilating arrangements. The drill carriage at each of the six headings mounted a similar Roto-Clone fan, and two large blowers were provided in the surface plants at Shaft 2 and Shaft 3. At Shaft 2A were also provided two 5000 cubic feet per minute blowers that have served as standby units for underground ventilation when work at the two headings was suspended. They have prevented any accumulation of an explosive mixture of methane gas and arrested any longitudinal dispersion of the gas, which would naturally rise to the roof of the tunnel and spread.

It will be understood that the ventilating system was designed in the first place to keep the dust count in the tunnel sections below 10,000,000 parts per cubic foot of tunnel air, as prescribed by the New York State Silicosis Code, and incidentally to be ample enough to catch and dispose of any methane gas that might be released at a heading. In view of the distances between the access shafts, down which fresh air was to move and travel thence to the headings as they advanced farther and farther from a shaft, and with consideration of the other conditions imposed, the contractor deemed the employment of his blowers as suction units as likely to offer the best solution of a difficult problem. That he was right has been attested to by visiting experts of the U.S. Bureau of Mines, who have remarked upon the absence of fog and fumes in tunnel sections while excavating was under way, and have been impressed by the invigorating quality of the steadily moving air and the excellent visibility.

The heading north from Shaft 2A was driven a total distance of approximately 15,550ft., and during that work a fire boss was always in attendance to detect any escape of methane gas, and to order the men away from the heading whenever the gas was present if it approached the prescribed limit. The men were fully instructed as to the explosive nature of the gas, and it was found that the flame safety lamp was the only dependable means of quickly discovering the presence of methane. The men were not permitted to return to a face after shooting a round until the fire boss had tested the atmosphere at the face for methane and any other toxic gas and had given the " all clear " signal to them. The procedure was virtually that followed in a gassy coal mine, and the same course was adopted at all six of the headings. Neither smoking nor the carrying of matches was allowed anywhere in the various tunnel sections.



SINGLE DRUM 500 H.P. HOIST AT ACCESS SHAFT

ROTARY CAR DUMPER AT BOTTOM OF ACCESS SHAFT

### TUNNEL DRIVING PROCEDURE

The drilling at each face was done from a drill carriage, built of structural steel, which was equipped with collapsible wings that could be folded out of the way when not in use. The carriage moved to and from the heading on the single main line of track of 36in. gauge. While excavating continued the main track had, back from the heading, sidings 180ft. long, with turnouts. Each drill carriage mounted from five to seven 3½in. wet type drifters that used drill steels having a maximum length of 15ft., and 2ft. changes were used. In practice, a round consisted of from forty to fifty holes; and, depending upon the rock in each case, the holes varied from 8ft. to 14ft. in depth. Likewise, the number of rounds per diem varied from six to nine during three shifts.

When the drilling of a round was completed, electric current at the heading was cut off from a point 1500ft. back from the face, putting out the Crouse-Hinds explosion-proof flood-lights at the heading. The holes were loaded from the drill carriage, and the

men worked by the light of electric cap lamps. An average of 4·08 lb. of 40 per cent. dynamite was used per cubic yard of rock, on the entire job, but there were variations, ranging from about 3·6 lb. to a maximum of 6·58 lb. per cubic yard in dealing with the different kinds of rock encountered. The firing was done with from 0 to No. 6 delays, using shunted exploders in safety primers. An air-water spray, about 60ft. back from the face, was brought into action shortly before firing, and the spray was effective in laying dust and reducing any concentration of toxic gases, so that the exhaust ventilation system was effective in removing explosion fumes and in clearing the air inside ten minutes after the shooting.

When the fire boss gave the all-clear signal after a shot, a 75 H.P. Conway mucker accompanied the men returning to the heading. The machine first cleaned up fly rock and then went to work on the main muck pile, safety miners simultaneously scaling the roof and the face. Where needed, 15ft. crown bars, with blocking, were erected to support the roof, and this work was done from on top of the muck pile.

To use the mucking machine to its fullest capacity, empty muck cars had to be moved to the loading position at the rear of the Conway unit as each car was loaded. The empty car next to take its station at the mucker was lifted from the rear end of the muck train, held aloft while the train backed, and then the suspended car was lowered to the track at the front of the train and pushed up to the loading position. On Contract 313 the "cherry picker" for this service was merely a block attached either to the steel roof support or to an expansion bolt anchored in sound rock overhead. A five-part line, with a single line running to a small pneumatic hoist at the side wall of the tunnel, sufficed for the lifting and lowering of an empty muck car. The cherry pickers could be shifted quickly to a new working point as the heading advanced. The muck cars were simple steel boxes, ruggedly built after a design by the contractors' engineering force, and each car was mounted on four roller-bearing wheels, and suitably equipped with draught gear and springs. A car could be lifted by the cherry picker by engaging the two hooks of a bridle to two eyes secured at opposite sides within the car body. Each car had a water level capacity of 6 cubic yards, and its "streamlined" exterior was adopted to facilitate entering and leaving the rotary dumpers at the bottom of a shaft. On the 2·31 per cent. gradient north from Shaft 2, the descending loaded trains were made up of eight cars, and on the level stretches of the tunnel the trains were of like length. Each train was handled during the period of tunnel driving by a 13-ton Goodman storage battery locomotive having motors that develop 90 H.P. at 110 volts. Batteries were changed, when the locomotives were operating on long hauls, about every six hours, the batteries for the locomotives assigned to each shaft being charged at an underground station.

Of the more than 75,000ft. of tunnel driven under the contract, the greater part pierced a rock formation consisting of interbedded Hudson River sandstone and shale lying generally horizontally with only occasional dips of as much as 35 deg. Beneath Shawangunk Mountain, which represented an overburden 2400ft. deep imposed upon the tunnel, the pressure induced very pronounced stresses that caused what is popularly described as "popping rock"—pieces of various sizes being driven out with considerable force. In the tunnel section directly beneath Rondout Valley advance had to be made for a distance of 750ft. and was driven through a much faulted and crushed zone where large volumes of water had to be dealt with, and after that stretch was passed, for the succeeding 2236ft., the heading had to be driven through a hard grit formation that presented a problem in itself.

Without going into details, and taking as a whole the tunnel driving job from end to end of the contract, the average progress daily at each shaft and at two headings was 63·04ft., and the best total progress at three shafts and six headings for thirty-one consecutive working days was 6779ft. By having six headings the contractor could make steady advance at some of them while being slowed up or even stopped elsewhere. For example, at Shaft 3 the two headings, working north and south respectively, made during a single month and in twenty-six working days an advance of 2219ft.

*(To be continued)*

# Canadian Locomotive Experiences

By EDWARD H. LIVESAY

No. IV—*(Continued from page 233, September 18th)*

CANADIAN PACIFIC RAILWAY, TRANSCONTINENTAL, RETURN: WINNIPEG TO KENORA

WINNIPEG lies roughly midway between Vancouver and Montreal, in a bottleneck bounded on the south by the Canadian-American border, and on the north by the shore of Lake Winnipeg, one of the great bodies of fresh water for which the Continent is remarkable. Both the Transcontinental lines pass through the city, and have repair shops and marshalling yards there, the C.P.R. yard being reputedly the largest in the world, with a trackage of over 100 miles. This accommodation is provided chiefly to take care of the flood of wheat that pours through Winnipeg every year *en route* to Fort William and Port Arthur, the twin cities at the head of the Great Lakes, whence it is shipped in grain tankers to the outside world *viâ* the St. Lawrence. Winnipeg is near, but not quite coincident with the eastern edge of the prairie wheat fields, which is about 50 miles farther on, the change from the black loam soil to forest country, rock and lake being almost a sudden transformation, the rough wilderness extending thence for hundreds of miles east along the northern shores of Lakes Superior and Huron to Sudbury, the nickel-copper centre.

The C.P.R. was the first Transcontinental line to come through Winnipeg from the east, twenty-odd years before the Canadian Northern and Grand Trunk Pacific followed its example. Originally only a single track was provided, but line revision soon began, later to be coupled with double tracking as the traffic increased, and this resulted in considerable left-hand operation, though the right-hand rule is almost universal in North America; it came about in the following way. The heaviest trains are the eastbound freights, so the easiest possible gradient was plotted for traffic in this direction when the new track was laid down, the best location for it being found to lie as a rule north—that is, to the left—of the original line, though this is not exactly a law of the Medes and Persians; here and there the old line is still used for the heavy eastbound trains, in which case the new line lies to the south of it, the distance between the two varying from the usual 13ft. to as much as half a mile. In some places the old line was discarded altogether, and a better location found for both tracks. Standard right-hand operation is worked for 30 miles going east from Winnipeg, to near Molson, but from this point the diversified conditions described above extend right into Fort William. A great deal of this line revision has been carried out by the C.P.R. since it was first built, as in those days it was often necessary—largely for reasons of finance—to adopt alignments and gradients that were sure to call for betterment later. Opportunities for this in railway construction occur through all sorts of country, but particularly where a line is rushed to completion against a time limit through rough and broken terrain. A vast amount of revision has been carried out in the vicinity of the Great Lakes and in British Columbia, where these conditions prevailed.

The "Dominion" remains forty-five minutes in Winnipeg, for engine changing, car cleaning, and so forth, which gives passengers a tempting chance to stretch their legs by taking a walk up town—and incidentally to miss the train, as I once found out to my cost, which means detention overnight, and resuming the journey next morning. "No. 2832" came off here, as she had come through from Calgary, 832 miles, so I said farewell to her courageous crew, with the intention of continuing the trip in the train as far as Fort William, at any rate; I had had enough of locomotives for the time being. But I was undone by my dyed-in-the-wool habit of going along to the front of every train I travel by, to see what sort of an engine they have given me; if I miss this ritual I can never really enjoy a journey. On this occasion I discovered an old friend there—"No. 2850," the "Royal Engine"—and I could not resist the temptation to sit once more in one of the Seats of the Mighty, and find out whether this famous engine had been allowed to deteriorate since I had ridden on it a year before. With Enginemen Leitch and Kuppers in the cab, the "Dominion" pulled out punctually at 6.45 p.m., still made up of thirteen cars, say, 950 tons, and in a drizzle that induced a little slipping, in spite of the booster with which "No. 2850" is fitted. This auxiliary raises the tractive effort 27 per cent., from 45,000 lb. to 57,000 lb., and its smooth drive, the result of the 2·47 to 1 gear reduction and high rate of revolution, is of considerable value in giving an easy get-away, without the tremendous snatch for which heavy American trains are unpleasantly notorious. I have been asked about this more than once, so it may be worth while explaining its why and wherefore. It arises from the generous amount of slack in the automatic couplings standard in America, these also incorporating a spring buffing device to absorb some of the shocks of coupling-up. Altogether there is approximately a total of 6in. "lost motion" in each coupling, when maximum compression and tension are also taken into account, or perhaps 12in. between two cars. If a train is long and heavy, or has come to rest under such circumstances as to make a restart difficult—say, on a curve, gradient or wet rails, or with the engine's valves so placed as to make reversal necessary before it can

go ahead—it may be necessary for the engine to back up first, taking up several feet of slack in the fore part of the train, and compressing the buffing springs as well. Then, with the reverse gear thrown quickly forward again before the rear part of the train also begins to move backward, the fore part of the train is in motion with the rear part still stationary, the result being a terrific jolt felt throughout the train, but most violently in the rear cars, which are jerked into movement by an engine by this time moving at several miles per hour. It is this slack in the automatic couplings that makes it possible for an engine to start a heavy train "part at a time"—trains that otherwise one engine could not handle at all. Of course, the same thing is true, I suppose, to a certain extent with screw-coupled British stock, but the slack is far less, and the loads lighter, so the jolts are not so severe. A twenty-car American train weighing about 1500 tons has some 15ft. of slack in its couplings, and is a considerable load for one engine to start. The resulting jerk can be fearsome. A booster is particularly valuable under such conditions, as the slack can be taken up more gently—it acts as a check-rein on the violence of the main cylinders.

Many American railwaymen who inspected the "Coronation" and "Royal Scot" out here were inclined to criticise the light construction of the cars, and expressed doubts as to their having long life. They failed to take into account the fact that English rolling stock is handled far more gently than American; nobody in England would put up for a moment with the shocks and jolts that our American cousins accept as a matter of course, because they have always had to, and which are inevitable when such heavy loads are handled. The effect of ultra-massive cars is felt as a vicious circle—the heavier the train, the heavier must be the structure of the cars of which it is composed, this, in turn, increasing the unpaying load. Carelessness in handling heavy engines comes into the picture, too. I have seen—and felt—a 300-ton engine come back on to a train at 3 or 4 m.p.h., and the resulting earthquake can be left to the reader's imagination—and to the passengers' exasperation.

The necessity for these very heavy cars has been discounted in recent years, and there has been tardy recognition of the fact that a vast amount of useless weight has been trundled about the country in the past. The latest welded cars weigh very little more than British stock, but difficulty arises when light and heavy cars get together in the same train, the former being apt to suffer from proximity to their weightier brethren. The lightest stock of all, the streamlined stuff, can only be used *en bloc* in complete trains.

"No. 2850's" cab fittings and controls were similar to those of other "2800" class engines, which were dealt with and illustrated in THE ENGINEER of May 30th, 1941. I noticed an additional gauge, bringing the fireman's group up to seven. It showed the pressure in the jet blowing fuel into the centre of the grate. In the previous arrangement the jets were all lumped together in one gauge, but with this latest lay-out another gauge gives the same information about the jets to the two front corners of the box, so three of the five jets have individual indicators. Further, there is no deflector plate to direct fuel right or left in the box. This is, I believe, the latest type of stoker. I do not remember noticing it before. The other gauges on the fireman's side concerned the stoker engine—which is in the tender with these engines—steam heat, feed heater, boiler pressure, and booster. The engineer gets off more easily, having only three gauges on his side—two for the air brake and exhaust pressure, the latter often seeming inaccurate and getting little attention anyway. All the gauges are electrically lit from a shaded roof lamp, but the water gauge has a light of its own.

I do not know if this Royal engine gets special care—probably not—but it was evidently in the same first-class condition as when I first made its acquaintance. Externally, it is distinguished by the Royal Arms on the smoke-box door, chromium-plated cylinder covers, and brake pump lagging. In the cab the wash-out plugs are neatly capped, the back plate polished steel, and the seats rather better finished than usual. These "2800" class engines are fine-looking machines in their chocolate, black and gold livery, and, in common with most C.P.R. engines, are well cared for. In Canada one seldom sees an engine starting out on a run in the grimy, unkempt condition so common, alas, in Britain—except on the Southern Railway—though naturally at the end of a trip that may have extended to upwards of 900 miles a locomotive is sure to show signs of having borne the burden and heat of the day. It is not possible for it still to be in immaculate condition. I was told by an official that "No. 2850" had run 90,900 miles in six months and 140,000 miles between heavy shoppings—or these figures may have been the average of the performances of the class, I am no longer sure which.

The double track out of Winnipeg to the eastern Manitoba boundary has some long straights, one extending for 35 miles, and along it speed was high, 70–75 m.p.h. Considerable electrical welding of rail joints has been done on this division, and when we were passing over metals so treated I tuned up my senses to note whether the riding was improved thereby. Verdict: I should not like to swear that it was, though theoretically, of course, it ought to have been! From this guarded judgment the reader will gather there could not have been much difference; I do think it was a little more silent. I was told that only four or five successive joints are welded, which gives continuous lengths of about 200ft., an unwelded joint then being left to take care of expansion and contraction, probably considerable in this particular district, where the difference between the summer and winter extremes of temperature is as much as 180 deg.—from 50 deg. below zero to 130 deg. in the sun. The standard American rail length is only 39ft., and joints are staggered. The weight of the steel here is, I believe, about 100 lb. to the yard.

When dealing with "The Chinook" and "No. 3001" I mentioned noticing for the first time a foot-operated whistle; here it was again on "No. 2850." It is quite a good idea, and has evidently caught on, and is spreading. It is a considerable improvement on everlastingly hauling down on an exaggerated bell pull, the usual method where there is no pneumatic trigger. It is strange nobody thought of it before.

Nearing Whitemouth the line runs for several miles through dead level muskeg, or peat bog, covered with tens of thousands of stunted little tamarack and spruce trees, where I noticed that the surface peat was being worked quite extensively. Making inquiries about this later, I was told that these and many other peat beds in Eastern Manitoba and Western Ontario are part of vast fields that run far up into the North-West. Until recently they were of little use, except for working on a small scale for peat fuel, for which there is practically no market. Lately the top layer of muskeg, or peat, has been found to make excellent building insulation, when thoroughly dried and shaken. It is a strong light fibre that can easily be cut with proper machinery, the supply is practically inexhaustible, and it is possible that in the future a large industry may develop from the utilisation of this material. These Whitemouth beds have been supplying a good deal of insulation material to the American market, and some has been used locally and in Winnipeg. Taking this subject a little further, it should be explained that a large proportion of North American buildings are of "frame" construction; that is, of lumber, with inside and outside boards nailed to 2in. by 4in. uprights, thus leaving a 4in. air space inside hollow walls; this is where the insulation material goes.

There must be millions of acres of this muskeg in the far north of Canada; it is no doubt similar to the tundra of Siberia. The stunted little fir trees reminded me that years ago the fine insulating quality of this peat had been brought home to me in another connection, when surveying in muskeg country north of Edmonton. Fir trees take root in this rich peaty soil, but its insulating effect is so good that it prevents the sub-surface thawing out, in spite of the long, hot northern summer days. It is always frozen underneath—possibly always has been frozen since the Ice Age! The unfortunate fir trees only have the top few inches of soil to grow in, and consequently never attain to any size. When we surveyors wanted ice water to drink on sultry summer days, we knew it was always obtainable under these wizened firs. It was only necessary to scrape away a little surface moss and let the warm air in on the frozen chocolate-coloured peat underneath, chop a little depression in this with an axe, and in a few minutes it would be full of ice water, cold enough to numb one's throat. Very delightful when sweltering at 100 deg. in the shade.

The first stop was at Whitemouth for water, made at 7.53 p.m., the 54 miles from Winnipeg having been covered in 68 min., 47 m.p.h. The level prairie came to an end quite suddenly about here, rock outcrop beginning, with more frequent curvature. Between Telford and Ingolf the Manitoba-Ontario border is crossed. The gradient had been rising steadily since leaving Winnipeg and just beyond Ingolf "No. 2850" suddenly kicked up her heels on a 1 in 200 incline, and had to be calmed with a dose of sand. This Lake of the Woods country is really very beautiful, in a wild, stern way; there is plenty of bush, and many fine sheets of water, stiff with fish—it is a sportsman's paradise. After the monotony of the prairie the contrast was all the more welcome, though you are apt to get rather tired of the wilderness before you reach Sudbury, 917 miles farther on, because of its sameness—rocks, muskeg, trees, lakes, *ad infinitum*. Fireman Kuppers was very enthusiastic about this district, and I agreed that it had its scenic points, but then he was from Winnipeg, and anyone living on that pancake naturally would be charmed with hills and trees. To a British Columbian, such as myself, they are less of a novelty.

We were right out of the prairie now. No longer could one look ahead and see the metals converging to a point in the distance; there was plenty of curvature as "No. 2850" picked its way among the lakes and woods. Flange lubricators are fitted to this class; many people do not realise how old such devices really are, thinking of them as comparatively modern. My library includes Stretton's "Development of the Locomotive," published forty-five years ago, and with reference to Stroudley's "Gladstone" four-coupled-in-front class engines, a quotation reads: "To reduce the wear of the leading wheels, Mr. Stroudley arranged a pipe

leading from the bottom of the exhaust [*sic*—this is a very badly written book !] in order to turn a jet of steam against the flange of each leading wheel, the cold wheel condenses the steam and lubricates the flange, and when running round sharp curves, especially in dry weather, the grinding noise of leading wheels, so often observed upon many lines, is consequently avoided." The "Gladstones" came out in 1882, and the last one only disappeared about 1934, I believe, so at any rate the idea of flange lubrication goes back sixty years, even if this was the first instance of it. Apparently flange lubrication by means of a device fixed to the rails has been tried, too. It has been in use for some years on the Cambrian Coast section of the G.W.R., according to *The Railway Magazine*. An oil box is fixed to the inside of the outer rail on a curve, with wicks projecting upwards in contact with the railhead. These wicks are squeezed between flanges and railhead as the wheels pass them, the flanges picking up a little oil which lubricates them on curves. If I may be allowed the colloquialism, "This is a new one on me!"

The shades of night were falling as we passed over the border into Ontario, and observation outside the cab began to give place to conversation inside. As is often the case, a little confusion arose from differing railway terminology on the two sides of the Atlantic. Idly watching the track streaming towards the engine, lit up by the white glare of the headlight, I thoughtlessly queried, "How far apart are the sleepers put in this country?" "They aren't put apart," came the reply; "they are all together in the middle of the train." Evidently a derangement of epitaphs—I should have said "ties." It reminded me of the American business woman in Paris, entertaining some masculine colleagues to lunch, and the misunderstanding that arose with the waiter through a whispered query. At the conclusion of the meal, not wanting to make the payment of the bill too obvious, she said in a very pianissimo aside to the waiter, "L'addition, s'il vous plait." "Downstairs to the left, madame," came the equally discreet reply.

American railway terms often sound quaint to the uninitiated. One really needs a glossary at times to avoid being left at the post. Some are legitimate enough, though personally I never can think "engineer" for driver comes into this category. It no doubt originated in the American congenital love of "talking big." But, at any rate, it is better than "hoghead," the other title you have a right to bestow on him, and both sound less derogatory than the fireman's by-name "tallow-pot." A guard is a conductor; a passenger train a varnish; a shunting engine a goat; and a rail-car a gas-buggy. The reader doubtless has his own idea of what an inspirator or a ram ought to be, but he is probably wrong—it is an injector. An engine is sometimes nicknamed a hog; when it is unpopular with the crew I have heard it called other names which pained me, but left no doubt whatever of the opinion held of both it and its ancestry. The footplate is known as the deck; and the reverse lever (when there is one) the Johnson-bar—please do not ask me why. And so on, but space forbids. I have noticed in Canada what I also did in England, that enginemen seldom know anything about wheel notation. Refer to "the big 2–10–4s" and the remark wastes its sweetness on the desert air; mention "the 5920s" and you get an immediate response.

Kenora, the end of the division, is 125 miles from Winnipeg, and we were now closing it. The name is an improvement on the original one, Rat Portage. It is at the head of the beautiful Lake of the Woods, and is a summer resort for jaded Winnipeggers who have cottages there, to which they come at week-ends for yachting, fishing, and so on—and to get bitten to death by mosquitoes. The "Dominion" arrived on time at 9.40 p.m., after covering the 125 miles, with three stops, in 175 min., 43 m.p.h. Here I left "No. 2850," retiring to the comfort of an air-conditioned car for the rest of the distance to Fort William. Something about air conditioning may fittingly find a place here. It has been adopted extensively throughout the North American continent, where climatic extremes make it far more necessary than in Britain. In Canada it naturally presents additional problems, as not only are temperatures so vastly different in summer and winter, but they vary from coast to coast. Ventilation, cooling, heating, humidification, and dehumidification—all have to be taken into account. Cowls, open windows, &c., cannot be used to control ventilation, so a combination of electrically driven fans with sealed windows has been adopted. Two fans are used in each car—one a blower for circulating the air, and the other an exhaust fan for expelling the foul air. To obtain equal temperatures and velocities, the air may be delivered by either the duct or bulkhead system. There are usually two delivery ducts in the former system, placed in the ceiling of the car, the air from these being delivered from diffusers either running the full length or placed at intervals, and in the various compartments. In the bulkhead system one or two fan units are placed in each compartment, the air being diffused direct from them. About 75 per cent. of the air circulated is drawn from the body of the car and mixed with air drawn from outside. It is all filtered before it is recirculated, which prevents dust and fumes entering the car.

Cooling of the air is done by a coil placed in the air stream close to the blower fan. It consists of finned tubes, cooled by cold water. In the ice-activated system the water used to cool the coil is constantly circulated over the ice, which is stored in insulated boxes under each car, and passed through the coil by an electrically driven pump. The ice boxes usually contain about 5000 lb.

It is obvious that the temperature must be controlled by the cooling system, and not by the fans, as merely stopping the fans would cut off the air supply. Control of the cooling may be done by turning off the pump thermostatically when the desired temperature is reached, but this has the drawback that in very hot weather the sudden change causes uneven temperature, and increases the relative humidity. To prevent this, a water reservoir, called the "sump," and a by-pass valve are used, placed in the water line. When the desired temperature is reached the by-pass valve, thermostatically operated, diverts the flow of water from the ice box to the sump, which brings the latter into circulation with the coil. The water in the sump, though supplied by the ice box, rises in temperature after it has been a short time in circulation; the change in temperature is thus not so sudden. However, this, too, has a disadvantage, as the water is usually above dew point, and the condensation that gathers on the coils is carried into the car, to increase the humidity. The same apparatus is used for heating the cars, but I will come back to that in a later article.

It will be seen that air conditioning means a considerable additional load. The ice alone, 2½ tons per car, in a fifteen-car train adds up to 37½ tons, and on a hot day has to be renewed at nearly every divisional point. The only complaint I have is that the cars sometimes seem over-cooled, especially when you come into one after walking about outside, possibly in air that may be over 100 in the shade. It feels like taking up residence in a refrigerator. Nevertheless, I vastly prefer the newer type of car; the old type can be perfectly damnable, suffocatingly hot, and smell like a garbage can. During this very trip it happened that for my sins I covered a whole division in a crowded "coach"—the equivalent of British third class—minus air conditioning. The contrast was indeed striking. It was a hot day, and the car was packed; every seat taken, and people standing in the vestibules—most trains in Canada seem to be packed these days, with Service men on leave, or travelling here, there and everywhere. I was forced to open a window to avoid asphyxiation, and at once in swirled the dust from the ballast, accompanied by smoke and grit from the engine. After an hour or so I felt as if I had spent the night in a dustbin—and looked like it, too. The car had never been swept since leaving Toronto the evening before, and as coach passengers always use the floor as the only receptacle in which to dump all the things they no longer have any interest in—food containers, cigarette boxes, newspapers, orange peel, &c.—the car looked like a blitzed rubbish heap. I am not a snob, but when I gazed on the disorder and its undisciplined cause, my lip curled and both nose and eyebrows went up! I even wondered if such a sight could be seen in Adolphland. Only once in my life can I remember travelling in a worse "fug"—when a lad, going from East Croydon to London Bridge by a workman's train, jammed in an old smelly compartment with a dozen navvies, all smoking shag, both windows tight shut. Phew!

Concluding this article with a few words about the booster, it is used far more extensively on American express engines than on British, the tentative experiments made with it on the latter being soon given up. There were several reasons for this, and one may have been the difference between express trains on the two sides of the Atlantic. Where stops are very frequent the booster is valuable, but it would be far less so with British trains doing their hundreds of miles non-stop. To be worth while as an auxiliary with such trains the booster would have to be available at comparatively high speed up gradients, which would involve a higher gear, reduced tractive power, and increased steam consumption, and the limited boiler power of the average British engine would probably preclude this modification of the usual type of booster. Unless I am mistaken, a booster available at fairly high speed was fitted to a Raven "Atlantic" a few years ago on an "articulated bogie"—common to engine and tender—and the accounts of the trials were encouraging, but I have seen no reference to its since. The limitations of boiler and fire-box may have cropped up, possibly, or there may have been something wrong with design or construction. The booster is quite reliable out here, and trouble-free. But I should doubt if there is really much of a field for the booster in Britain, where the average boiler already has enough to do to satisfy the main cylinders, without a couple more being added to its burden.

The ground has now been covered in some detail from Vancouver to Kenora, 1600 miles, and the rest of the way to Toronto was dealt with in the "Dominion" articles last year. The last lap came into No. II of the "Fast Trains" series—Montreal to Toronto. I shall

pass over the return journey as far as Calgary to avoid repetition, as the same class of engine is involved all the way, but with the reader's permission I shall have a little more to say about the Mountain divisions. I never get tired of them, and I hope the reader is not either.

*(To be continued)*

# The Merchant Marine*

By the Right Hon. LORD MOTTISTONE

OWING to the war, the Council of the Institute have thought it well that I should give my Presidential Address on this occasion, rather than that there should be a special meeting for the purpose. In spite of my high sense of the honour which you have conferred upon me by making me your President, I intend to be brief, partly because brevity is always desirable, and partly because we all are anxious to hear the Parsons Memorial Lecture by Dr. Dorey which is to follow.

There are three subjects of outstanding importance to which, as your President, I wish to refer. It so happens that I have been concerned in or have some knowledge of all of them. The first is the great advance which has been foreshadowed to us in the consideration of the future status of marine engineers and of the merchant navy generally. As the representative of this great Institute, I wrote to Lord Leathers, the Minister of War Transport, after a personal interview with him, the following letter :—

The Council of the Institute of Marine Engineers, of which I am President, have asked me to forward the enclosed proposals to you. They were anxious to put their views forward in the right manner, and I told them it would be right for them to send their proposals to you as Minister in the first instance.

The Institute has a membership of over 4000 merchant engineers, of whom nearly 50 per cent. are actually seagoing officers at the present time. Being a scientific body, they only include in their membership those with certain attainments.

The Council wish me to take this opportunity of expressing their cordial thanks for the great help which many high officials of your Ministry have given, and are giving, to them, especially on the scientific side of their work.

Knowing how anxious you are to secure good conditions of service for the merchant engineers, both during this war, in which they are rendering such exceptional service, and in the days to come, I do not hesitate to bring these proposals to your notice, in the hope that you may be able to incorporate some of them in the great scheme which you will in due course lay before Parliament.

I was able to write that because Lord Leathers had stated publicly in the House of Lords, and had also informed me personally, that he was bringing forward at the right time some far-reaching proposals of which he said to me : "I believe they will not be unsatisfactory to the merchant navy, and not least to that important branch of it with which you are concerned as President of the Institute of Marine Engineers."

Lord Leathers acknowledged that letter, asking me to thank the Council for their appreciation of the help given by his officials, and saying that he would write to me again when he had fully considered the proposals I had sent to him. This is his reply :—

MY DEAR MOTTISTONE,—I am writing to thank you for your letter of July 23rd, with which you enclosed a memorandum on the training, grading, and conditions of service of engineers in the merchant navy that had been prepared by the Council of the Institute of Marine Engineers.

You may remember that last February during a debate in the House of Lords on the future of the Merchant Navy I announced that I had asked the National Maritime Board to expedite their consideration of plans for continuity of employment and for the improvement of the methods of entry and training of seagoing personnel after the war. I am glad to say that the National Maritime Board and the Merchant Navy Training Board have already made considerable progress.

In the detailed discussions about reconstruction which must presently take place, the suggestions put forward by the Institute of Marine Engineers, which are now being examined very closely by my technical advisers, will be of great value, and I shall be glad if you will convey my thanks to the Council of the Institute and assure them that their proposals are being considered very carefully.

That is expressed in official language, but it means that he will probably be able to adopt a good many of them. He concludes :

May I add my good wishes for the continued prosperity of the Institute ?

I think you will agree with me that that is a highly satisfactory letter, which Mr. Curling will be able to keep in the archives for future reference. I hope and believe that the status of the marine engineers will be carefully considered and improved.

My next point will show, I think, that high on the list of those to whom our gratitude is due for the help which they have given we shall have to put the name of the great seaman who has honoured us by his presence this evening, Admiral of the Fleet Lord Chatfield. Many debates have taken place in the House of Lords, in most of which I have taken some small part as representing our Institute, and also, I hope, as a friend of merchant seamen for the last seventy years or so, debates more than once initiated by Lord Marchwood, but also initiated by that stout-hearted friend of yours, Lord Cork and Orrery, who is also an Admiral of the Fleet, and their plea has always been that as far as possible there should be equality of treatment for the merchant navy with the Royal Navy in the matter of awards for gallantry.

There was a brief account of the most recent debate in *The Times*, but in these days of paper shortage only the briefest reports can be published, and so I have here a copy of Hansard, from which, as the matter is so important, I will read a few extracts. Without reading all the speeches, I may say that the speech of Lord Chatfield was of outstanding service in getting something done, and that Lord Cork and Orrery and one or two other members of the House of Lords, all of whom supported the plea for equality, also rendered great service. All the members of the Royal Navy who were present cordially endorsed the desire that the merchant navy should be on the same footing as the Royal Navy in the matter of rewards for gallant service in the face of the enemy. In replying to the debate, Lord Leathers, after some preliminary remarks, said :—

I should like, first of all, to give a brief account of the awards and decorations that have been made to officers and men of the merchant navy and fishing fleets since the war began. . . . We have now had three years of war. In the first year 353 awards to members of the merchant navy were gazetted. In the second year there were 815, and in the third year 1383, making a total of 2551 awards from the beginning of the war up to August 31st, 1942. It is interesting that nearly 200 of these awards have been to foreign nationals who have been serving in our cause.

These were largely, I understand, to members of the Norwegian merchant navy.

The total of 2551 includes, besides Commendations and Mentions, 468 British Empire Medals, 12 Sea Gallantry Medals, 29 George Medals, 72 Distinguished Service Medals, 4 Albert Medals, 68 Distinguished Service Crosses, 365 M.B.E.s, 332 O.B.E.s, 8 C.B.E.s, 1 Knighthood, and 3 George Crosses. Noble Lords will realise that over 700 officers of the merchant navy have been appointed Members, Officers, or Commanders of the Order of the British Empire. Apart from two Dunkirk cases, all those have been included in the Civil Division of that Order.

In the case of Dunkirk they broke the rule, and in two cases gave similar awards to those given to the Royal Navy.

After pointing out what a high Order the Order of the British Empire is, and how rare it has now become, Lord Leathers went on to say :—

Now, if I may, I wish to turn to the military decorations which are from time to time awarded to members of the Services, and to state precisely what the position of the merchant navy is. There is first the Victoria Cross. Officers and men of the merchant navy are eligible for this unique distinction. They are also eligible for the Distinguished Service Cross for services in action with the enemy, and 68 officers of the merchant navy have been honoured by this Cross. As regards the other military decorations, officers and men of the merchant navy have been eligible for the Distinguished Service Order, the Conspicuous Gallantry Medal, or the Distinguished Service Medal.

They were not previously eligible for the D.S.O., but Lord Leathers went on to say :

I am very happy to announce that His Majesty the King has graciously approved that the statute of the D.S.O. should be amended so as to cover officers of the merchant navy for services in action with the enemy. Noble Lords will very shortly see gazetted awards made in connection with the recent Russia and Malta convoys. These will include a number of D.S.O.s for merchant navy officers who took part in those operations.

The D.C.M. was issued nearly seventy years ago for petty officers and seamen of the Royal Navy and N.C.O.s and others who distinguished themselves by acts of conspicuous gallantry in action with the enemy. His Majesty the King has also approved that an Order in Council should be made to provide that this Medal also may be awarded to equivalent ranks in the merchant navy for gallantry in action with the enemy. Then there is the D.S.M. I am glad to be able to state that His Majesty has been graciously pleased to allow seamen in the merchant navy to be awarded this Medal for special conduct.

You will see therefore that the merchant navy is now absolutely one service with the great Royal Navy in this matter of awards for distinguished service in face of the enemy.

There was one humorous incident in the debate which made even members of the House of Lords laugh. Lord Leathers concluded by saying :—

There was only one point in my noble friend Lord Marchwood's speech to which I feel I must take exception. He said, perhaps without thinking, that these officers, when going into these operations of war under great hazards, had uppermost in their minds awards. I do not believe they have them in mind at all.

Lord Marchwood rose to protest that he had never said any such thing. What he had actually said was : "When we go into action the last things we think about are awards." The Lord Chancellor beckoned to me with a smile, and, as I sat beside him on the Woolsack, he whispered : "Of course, there is a difference between saying, 'When I go into action the last thing I think about is the award I may receive' and 'When I go into action my last thoughts are of my wife,' although in both cases the same word, 'last,' is used ! "

I have dwelt at some length—I hope you will not think at undue length—on this subject because, as I was able to point out to Lord Leathers, half our members are actually serving at sea in this hazardous enterprise of convoy and in every kind of marine activity, all in the face of a determined enemy ; and, although, of course, the last thing that they think about is the award

* Institute of Marine Engineers, Presidential Address, September 16th, 1942.

they may receive, we think a good deal about it, and as a matter of fact they do appreciate awards. I happen to be a Companion of the Distinguished Service Order, and I rejoice to think that I shall now have as comrades people far more deserving than myself, people who have faced great dangers in the Battle of the Atlantic and on all the seven seas, my comrades, as I should like to call them, of the merchant navy. It must be a source of satisfaction to this Institute that, in addition to the awards which their members have received in the past, they will be able in the future to receive all the awards available to the brave men of the Royal Navy. In the name of the Council of this Institute, Lord Chatfield, I thank you and the other officers of the Royal Navy who helped you in Parliament to secure this very just recognition for our members.

The third and final matter to which I wish to refer is the Parsons Memorial Lecture, which we are going to hear from Dr. Dorey—the story of Dr. Dorey, I should like to call it. I have read it, and it is absorbingly interesting. It has an added interest to me by reason of the fact that, as a consequence of this Lecture, Dr. Dorey is to receive an immediate award in the form of a medal to be presented to him by the Fellow of the Royal Society, who has come here for that purpose, Professor Egerton, who will present to him the Parsons Memorial Medal.

It was my privilege to know Sir Charles Parsons, and to know him quite intimately and for a curious reason. After the last war my mind turned again to my first love, which was scientific discovery. I have found it an expensive pursuit. I conceived the idea that it was possible to utilise the properties of the gyroscope, both free and constrained, so as to find one's position on the surface of this globe without the use of dead reckoning or of observation of the heavenly bodies. The first person whom I consulted to see whether my thesis was correct was that famous Fellow of the Royal Society, and its President in 1915, Sir J. J. Thomson, the Master of Trinity, whose name will always be remembered in scientific circles with respectful awe. He had a great brain. He took about an hour to think it over, and then he said to himself: "The young man is right! Why did I never think of that before?" He then turned to me and said: "Go and see my friend Parsons."

Accordingly I went to see his friend Parsons, and for a long time I was in consultation with him. I also knew him socially, for he was a generous host; but on the scientific side it was wonderful to see the working of that marvellous brain. We did not spend much time on my invention, although he was very interested in it; he talked to me about other things, including some of the things about which Dr. Dorey is going to tell us in his story. The conclusion, for me, was sad; my money ran out, after I had spent £4000 which I could ill afford, and so I presented the results to the Air Ministry—who thanked me very much.

I cannot conclude without saying that it is a peculiar pleasure to me to occupy this Chair, and a great honour. I am indeed glad that during my first year of office I have been able to be concerned—I cannot put it higher than that—in the very satisfactory promises for the future and the highly satisfactory performances in the present to which I have referred.

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The Parsons Memorial Lecture, 1942, entitled "Sir Charles Parsons and Mechanical Gearing," was then delivered by Dr. S. F. Dorey. A reprint of it is concluded in this issue.

# Fen Flood Protection

No. III—(*Continued from page 235, September 18th*)

IT has been said, "Why do we propose a separate relief channel, and why do we not enlarge the Tidal River between Denver and Wiggenhall St. Germans, seeing that it is claimed that the Magdalen Bend barrage can maintain the bed of the Tidal River at a low level?" In fact, we have not made any such claim, and in any case it is a very different thing maintaining the existing bed level which Nature has produced, and fighting against it, as would be the case if a colossal scheme like that of Mr. Kraaijeveld was carried out, and an attempt made by means of the Magdalen Bend barrage to prevent the river silting up again.

The relief channel has a sluice at its tail at Wiggenhall St. Germans, which will prevent the entry of silt, and therefore it is much safer to carry the flood waters of the South Level by that route. The reason why it is suggested that the Tidal River should be enlarged instead of constructing a relief channel appears to be that it would produce a lower water level at Denver, and so assist the discharge of the Washlands. The flood protection scheme will, however, reduce the water level at Denver from 110ft. to 108ft. 6in., although I do not claim that this will have any appreciable effect on the lowering of water levels in the Washlands.

There never has been any difficulty about the discharge of water from the Washlands in flood when Welmore Lake sluice has been kept open. The real trouble is that the water going down the 100 Foot River from Welmore tends to block the discharge from the Ten Mile River from Denver. The reverse case does not happen. The water level in the Washlands always is higher than the water level in the Ten Mile River. Under the flood protection scheme, as I have said, the flood water level in the Tidal River at Denver will be lowered from 110ft. to 108ft. 6in. As you will see from Fig. 11, this will have a very small effect on the flood water levels in the Washlands. The reason for this is clear from Fig. 10.

The discharge of a channel is equal to the area of the water cross section × velocity, *i.e.*, $D = A \times V$. If we are dealing with the same discharge D and the same channel, and if the water level at the lower end of the channel is reduced by some means, works or other causes downstream, it is clear that the area of the mean water cross section $A_2$ must be less than $A_1$, because the water surface is lower. But $D = A_1 \times V_1$, and $D = A_2 \times V_2$, and therefore $A_1 \times V_1 = A_2 \times V_2$. $A_1$ being greater than $A_2$, $V_2$ must be greater than $V_1$, because we know that the discharge is the same and $A_1 \times V_1$ must be equal to $A_2 \times V_2$. If $V_2$ is greater than $V_1$, the surface water slope 2 must be greater than the surface water slope 1, and therefore the two surface slopes will meet at some point. In the case of the Washlands this is at Earith.

Including the 100 Foot River and the old Bedford or Delph, the Washlands are really a very large channel, and it would be impossible to reduce the water level on them to any great extent during flood, except by digging a large channel, something like that shown in Fig. 8. This would keep the water at Earith down to 112ft., the winter draw mark. You will see how it compares with the relief channel, and as it is more than twice the length, 20 miles against 9½ miles, it would cost about £1,000,000, and is obviously outside practical politics, and even if it were made and the flood level in the river at Earith reduced to 112ft., it would have little or no effect in reducing the flood level at Huntingdon. In order to reduce this level it would be necessary to continue the large channel up to that place, at great cost.

Returning to the Washlands themselves—Fig. 9—you will see that the floor is some 5ft. above the land level outside the bank of the Counterwash drain. Therefore, even if there was only a small depth of water on them, say, 4ft. 6in., there would still be a head on the Middle Level Barrier Bank of 9ft. 6in., between the water level in the Washlands and the land level outside the Counterwash drain.

A great deal of money has been recently spent on the Middle Level Barrier Bank, and there is no reason why it should not be safe against any water level which is likely to occur. Of course, it must be properly protected against erosion by wave action. At Earith it is estimated that the maximum flood will be 116ft., which gives a freeboard of 3ft. to the top of the bank at 119ft., and at Welches dam, where the estimated flood level is 114ft., there will be a freeboard of 5ft.

You will see that the South Level only has a freeboard of 3ft.—Fig. 9. I do not understand, therefore, why all the complaints about high water levels on the Washlands come from the Middle Level. For four-fifths of the length of the Washlands there are the Sutton, Mepal, Welney and Manea areas between the Washlands and the Middle Level; there is the Counterwash drain to reduce the head on the Barrier Bank, and it is a much higher and stronger section than the South Level Barrier Bank. Except for the 1¼ miles between Welmore and Denver, which have been remodelled recently, the bank is much lower and weaker, and at its

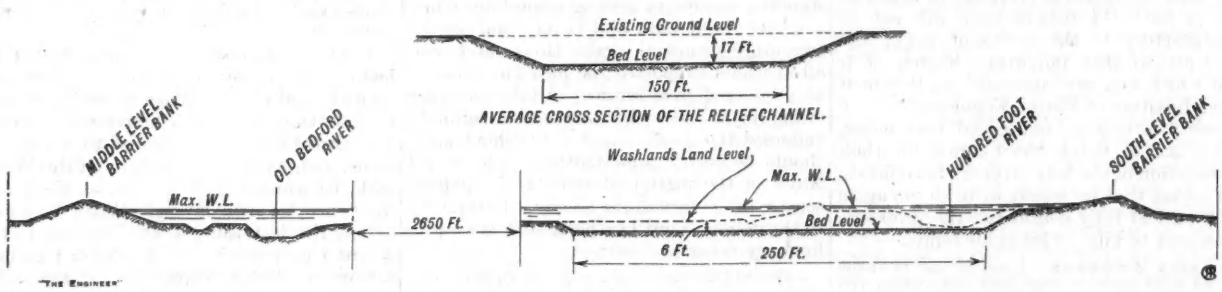


FIG. 8—WASHLANDS—CHANNEL REQUIRED TO LOWER LEVEL AT EARITH 4 FEET

north end is liable to have a tide level of 118ft. against it. I suppose the inhabitants of the South Level are accustomed to living on the brink of disaster. At present Mr. Doran tells

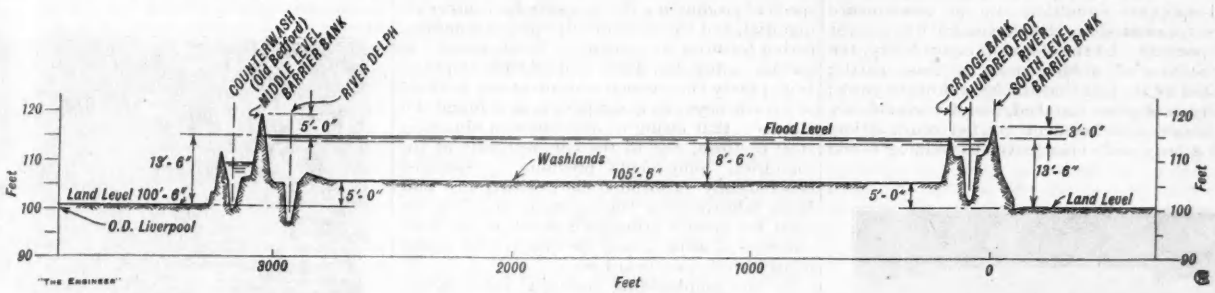


FIG. 9—CROSS SECTION OF WASHLANDS

me that parts of the River Wissey banks are 1ft. under maximum flood level, *i.e.*, they have a freeboard of minus 1ft.!

For some reason which is not quite clear to me, the Middle Level Barrier Bank has been made level at 119ft. I know the late chief engineer regulated on Welmore Lake sluice, and produced a horizontal water surface in the Washlands, but it appears to have been made with a level top before his day. Should even a higher flood than that estimated come down from Earith, it would be quite easy to increase the size and height of the bank at the south end, but even a freeboard of 3ft. gives a large margin for passing very much greater floods than that estimated as a maximum.

It is clear that the water in the Washlands cannot avoid being at a high level, and that it would be foolish to spend large sums of money trying to reduce this. The great thing is to see that the Middle Level Barrier Bank is kept in good order to withstand any possible flood which may occur.

It should be clearly understood that although a considerable amount of storage occurs in the

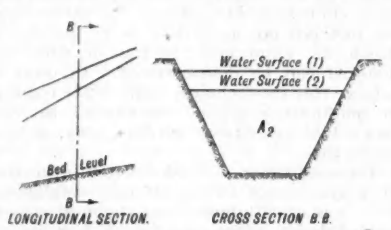


FIG. 10—DISCHARGE OF A CHANNEL

Washlands, due to the water rising in flood, it is really a carrying channel, and at the peak of the flood almost the whole discharge which passes Earith reaches Welmore and Denver.

With regard to the areas which drain directly into the Tidal River below Denver, it is true that at the peak day of a great flood the water level at low tide in the Tidal River at St. Germans will be raised by about 2ft., owing to the fact that the relief channel will get rid of the flood water from the South Level rivers earlier than at present. The actual amount of water passing to the sea from St. Germans will be the same, but it will be differently distributed. The average water level in the Tidal River will be the same as before. This would be of no importance if all the areas concerned had pumps of sufficient power and capacity, pumping directly into the Tidal River. Some of them, however, have not, and it is proposed that the necessary pumps should be provided at the expense of the scheme. This will not only prevent those areas being prejudiced by the flood protection scheme, but also improve their present condition. When the Middle Level Commissioners erected their pumping station at St. Germans, they raised the water level in the same way, but, of course, to a less extent, owing to the smaller amount of water dealt with. The principle, however, is the same.

Another work which is included in the scheme is the remodelling of the Tidal River embankments between Denver and St. Germans, in order to protect neighbouring lands from possible flooding due to breaches caused by high tides. A large amount of improvement work is also to be carried out in the upper reaches, but this is detail work which Mr. Doran, the chief engineer to the Catchment Board, will look after, and is not under our control.

Finally, I will tell you a little of the inner history of the scheme. Soon after we commenced our study at the end of May, 1939, Sir Murdoch MacDonald, our chief engineer (Mr. Kinder) and I came to the conclusion that the ideal solution was the complete cut-off channel. We fully realised, however, its great cost, although less than Mr. Kraaijeveld's river scheme, and also that it interfered with existing amenities such as the "Great River" round Cambridge. We therefore asked for an early opportunity to explain our proposal and get the Catchment Board to say whether they wished us to study the ideal or put up with the next best and less efficient scheme. Sir Murdoch therefore explained the scheme to the Board on July 20th, 1939, and without a single dissentient, the Board asked us to proceed with the study of the preliminary project for the complete cut-off channel.

We still adhere to what Sir Murdoch said then: "Works either in deepening or widening of the Tidal River, and constructing training walls at the outfall, in our opinion, are not the correct solution for the proper drainage and protection of the Fen Country."

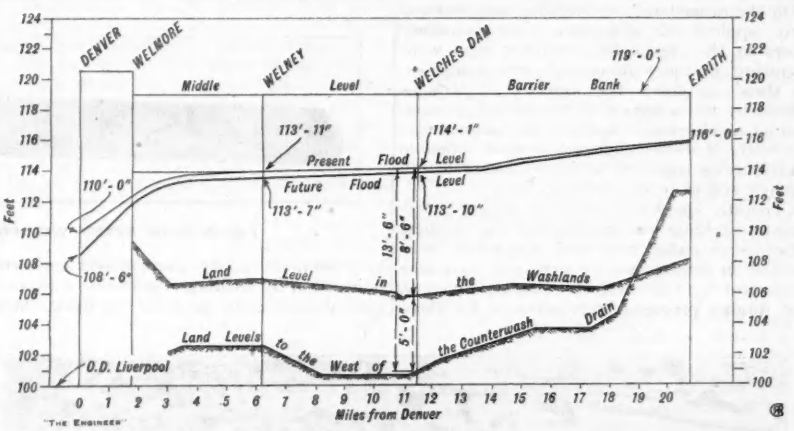


FIG. 11—LONGITUDINAL SECTION OF WASHLANDS

# Arc Welding and War Production

By E. C. DAVIES, A.M.I.E.E.*

No. I

SUMMARY

IT is generally recognised that electric welding has become one of the most important links in the chain of engineering production on which our war effort depends. The purpose of this article is primarily to emphasise the necessity of examining existing methods of manufacture with the object of introducing fabrication by arc welding as a means of replacing riveting, iron and steel casting, forging, &c., in order to speed up production and to conserve material and labour.

Secondly, it is suggested that by modernising welding methods and taking full advantage of the latest available information regarding high-speed welding technique, the time required for welding operations at present undertaken could in many instances be reduced materially. An attempt is made to indicate the main applications for high-speed welding and some of the advantages to be derived from their adoption.

Finally, some notes on the selection of welding plant are appended with a review of the relative merits of D.C. and A.C. welding; also some remarks are given concerning the applicability of single and multi-operator types of equipment.

The information regarding the principles of deep penetration technique contained in this article is based on investigations conducted recently by the General Electric Company, Ltd., Magnet House, Kingsway, London, W.C.2.

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## ARC WELDING UNDER PEACE AND WAR CONDITIONS

The period 1918–39 witnessed the emergence of fabrication by arc welding from what was virtually an experimental stage to the position of being recognised as a normal and efficient process, possessing many advantages over previously accepted methods of manufacture. The

extent to which it was adopted varied from industry to industry and was controlled largely by specific economic or commercial considerations.

Certain manufacturers, for instance, possessed well-equipped foundries, and in consequence were committed to the maximum use of cast components. In the shipbuilding industry, the application of welding was, at least partly, limited by the fact that the lay-out of the yards, the type of plant installed, and the availability of labour, was based on riveted construction, and a large-scale changeover to welding would have involved considerable capital expenditure and labour difficulties.

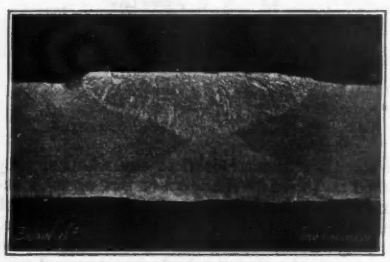


FIG. 1—MACROGRAPH OF BUTT WELD

On the other hand, arc welding was increasingly applied by numerous other manufacturers in the engineering industry who were operating in more favourable circumstances. In these instances the marked advantages offered by the adoption of arc welded fabrication as an alternative to previous manufacturing methods were recognised as most valuable contributions towards the improvement of the product and to production efficiency.

Generally speaking, therefore, during peacetime arc welding was applied to those products which were either improved and made more saleable in consequence or were produced at a lower cost by this method. Casting, riveting, and forging processes were retained for those products which, for mainly economic reasons, were considered to be unsuitable for fabrication by welding.

The advent of the war, however, created a new set of conditions. The call for maximum speed of production, the necessity for conserving material, and the need for alternative manufacturing facilities to overcome "bottle-necks" in certain industries, have shifted the emphasis from purely commercial considerations to those of expediency. In consequence, it is found, for instance, that owing to difficulties in obtaining steel castings, due to the commitments of the foundries, components previously considered economically unsuitable for welding are now being fabricated by this method. Further, the need for greater strength has led to the substitution of welded steel for cast iron on equipment installed on board ship.

In the shipbuilding industry there is the tendency to substitute welded structures for members formerly riveted or forged, in order to save steel and to accelerate building.

The use of arc welding is also responsible for the more rapid repair of war material damaged in action, this aspect often having a considerable bearing on the initial design, which in certain cases has been modified to include all-welded construction.

Many other examples of the wartime application of welding could be quoted to illustrate what has been done already in this direction, but there is no doubt that much more could be achieved with advantage. Reluctance to change over from previously standardised methods to fabrication by welding arises from a variety of reasons, one of the most serious being extreme conservatism or prejudice on the part of certain manufacturers, often traceable to lack of accurate information regarding the possibilities offered by modern welding technique.

Some sympathy is felt for engineers accustomed for a lifetime, perhaps, to certain conventional methods of manufacture and who are suddenly confronted with the problem of adopting unfamiliar and often revolutionary ideas. However, the country's interests demand that every effort should be made to ensure that welding methods are applied in every instance in which an appreciable saving in time and material can be demonstrated. In order to achieve this the technical staffs of the concerns in question should be encouraged to avail themselves of expert advice from welding specialists.

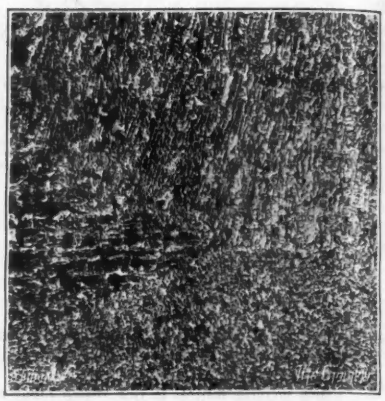
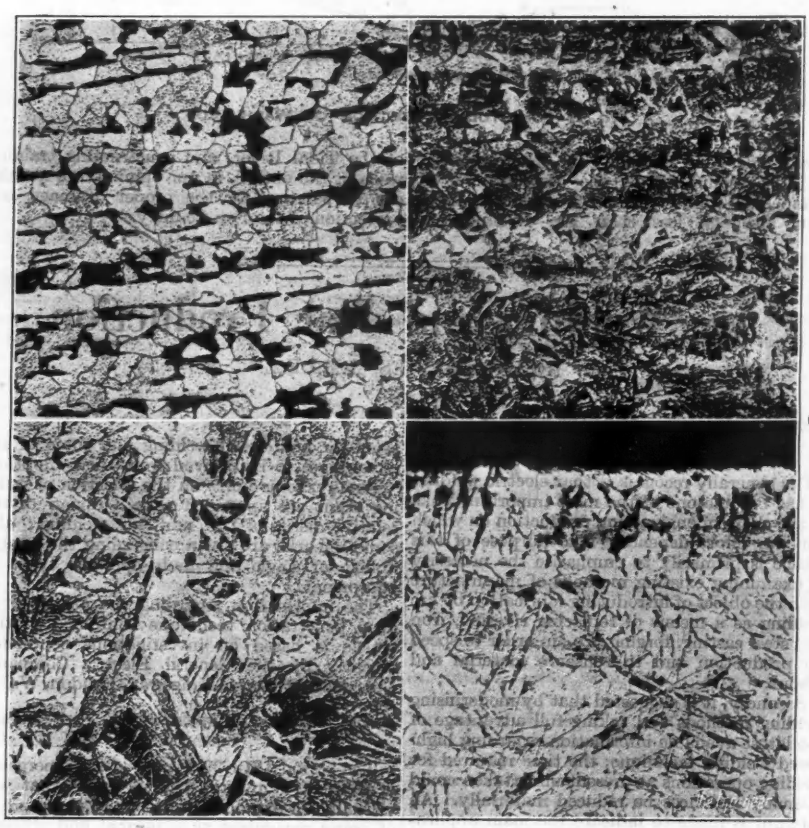


FIG. 3—JUNCTION OF FIRST AND SECOND DEPOSITS AND PARENT PLATE (× 25)

FIG. 4—HIGH SPEED WELDED TEST PIECE AFTER TENSILE TEST



Parent Plate
Junction Parent Plate and Weld Metal

Parent Plate in Thermally Disturbed Area
Outer Layer of Weld Metal

FIG. 2—PHOTOMICROGRAPHS OF BUTT WELD (× 100)

The need for specialised direction in matters of design cannot be too strongly emphasised, since it is usually found that the most efficient welded design differs considerably from its cast or riveted equivalent. The designer is guided not only by the availability of standard rolled plates and sections, but also by the desirability of carrying out as much welding as possible in the downhand position, which, as will be discussed later, enables the work to be performed at the maximum speed.

It is only after comparing a welded design, produced under the guidance of an expert, with that of a non-welded prototype, that it is possible to assess correctly the relative merits of the two. National emergency standards should, of course, be used for the comparison.

Shortage of skilled labour is undoubtedly one of the major difficulties to be overcome when considering any large-scale change-over to welding, but experience has shown that once a nucleus has been established, a steady supply of welders can be ensured by the institution of training departments within each organisation, fed by youths or girls. This system has the advantage of providing a more specialised type of instruction than could be expected from outside training centres and has been proved most valuable as a means of augmenting welding labour obtainable from other sources. In order to conserve the use of skilled welding labour, however, each operation should be carefully examined with the object of securing the maximum saving in time resulting from the adoption of modern welding methods.

### HIGH-SPEED WELDING

High-speed welding is essentially a process which enables a given connection to be com-

pleted in the minimum number of runs. This is achieved by the use of special electrodes, usually heavier in gauge than those employed in multiple-run welding, and coated with material designed to allow the rods to operate at a high current density whilst maintaining the quality of the metal deposited. As a result of this increase in arc energy, metal is deposited at a greater rate and with greater penetration than is possible otherwise, and the desired amount of material is thus deposited in the minimum number of layers.

The coating material of these high-speed electrodes usually consists of a large percentage of cellulose matter which evolves carbon monoxide and hydrogen during pyrolysis. The deoxidising effect of these gases is mainly responsible for the protection of the molten metal against atmospheric contamination during transfer from electrode to work, but a small amount of slag is also produced which blankets the deposited metal during the cooling period.

*Specific Advantages.*—Since high-speed welding involves the control of fairly large pools of molten metal, the characteristic of providing complete protection with a minimum amount of slag is one of the reasons for the freedom from trapped slag pockets obtainable from metal deposited from this class of electrode. In addition to the smaller amount of slag produced, the fact that most operations can be completed with a single layer of deposit eliminates the danger of slag inclusions capable of seriously weakening the connection, which in multiple-welding are often traceable to incomplete removal of slag from one run before the covering layer is deposited. The elimination of the time taken for this cleaning is also an important contribution towards maximum speed of production.

Distortion of the parent metal is also minimised by using high-speed deposition, owing to the greater concentration of welding heat, and an examination of the macrographs of typical high-speed welds will show the area of thermal disturbance to be surprisingly small for the amount of metal deposited.

Another most important advantage of high-speed welding is the ability to penetrate deeply into the parent plate and to dispense with the considerable amount of plate chamfering necessary when operating on heavy material and using multiple runs.

*Typical Applications.*—Fig. 1 is a reproduction of a butt weld between two ⅜in. thick mild steel plates. Before welding the two plates were tacked into position, leaving approximately ⅛in. gap between them, neither plate being chamfered. A single run was then deposited on each side, using ¼in. diameter electrodes and a current of approximately 550 amperes, each run being laid down at a speed of 2 min. per foot.

It will be seen that perfect union has been achieved, each weld having penetrated more than half the thickness of the plates, the root of the first deposit being adequately penetrated by the second run. Comparing this with a normal multi-run weld, it will be appreciated that the alternative would have involved producing a double chamfer on each plate edge and depositing a small run in the root of each side. After the removal of all slag, four or more further passes would have been necessary to restore the full plate thickness, each run requiring careful cleaning before applying the next. The saving in time as a result of employing high-speed welding will thus be seen to be very considerable.

It is true, of course, that during multi-run welding successive layers of deposit have a refining effect on the grain structure of those beneath, and that the grain size of metal deposited in single runs is coarse by comparison (refer to Figs. 2 and 3). The fact remains, however, that connections made by high-speed welding exhibit extremely good mechanical properties, and the tensile and fatigue strength, ductility, and resistance to corrosion are usually superior to those of the parent metal.

Fig. 4 illustrates a high-speed welded test piece similar to that shown in Fig. 1. The fracture occurred at a load corresponding to 29·1 tons per square inch, and took place at a distance of 6in. from the weld. The slight reinforcing of the plate thickness at the weld was deliberate, as in most practical applications this would represent the normal contour.

*(To be continued)*

## Sixty Years Ago

ARMED MERCHANTMEN

IN our issue of September 29th, 1882, we find a leading article entitled "Merchant Steamers as War Ships," in which it was recorded that the Government's long-discussed scheme for arming merchantmen in the event of war was at last beginning to take practical shape. An order had been issued for the despatch of armaments for twelve steamers, six to Bombay and six to Hong Kong. In addition, the Admiralty was offering inducements to shipowners to strengthen and modify their vessels in such a way as to fit them to carry guns. Privateering having been abolished, the position of an armed merchant vessel from the point of view of international law ought, we said, to be officially made clear. Further, before the Government proceeded in the matter it should state how it proposed to obtain the skilled men to operate the guns on merchant ships. If it was anticipated that competent seamen gunners would be found on board every steamer, the Admiralty, we felt sure, was making a mistake. The Admiralty, we complained, was very secretive on the whole subject. It had never even disclosed whether it was its intention to use the armed merchantmen as whole-time naval combatant vessels or whether it intended that they should be armed simply to protect themselves while following their ordinary mercantile avocations. We believed that it was probably its plan to use them as naval vessels—armed merchant cruisers, as we would now call them. In the event of war with a great naval Power we thought it was "morally certain" that our mercantile marine would leave the open sea as soon as possible and seek the shelter of neutral ports or else remain in British waters. Only a few of the more adventurous spirits would try to make a long voyage alone. Convoying might be resumed under somewhat different conditions from those which once obtained, but we ventured to say that very few merchant steamers would ever mount a gun. The risk incurred, the difficulty of obtaining trained gunners and the timorousness of capital would all act in the same direction. If merchant steamers were to be used as fighting ships they must be used for the time being for that purpose and no other. . . . So must the situation have appeared at that time to others besides ourselves. In pondering upon the manner in which events since then have falsified our forecast, we must remember that the "great naval Power" with which in those days we had to reckon was not Germany, but France.

## Unreasonably Fine Limits

IN a letter recently published, Sir Alfred Herbert says:—"On certain classes of work extreme accuracy is a virtue, and on such work fine limits must be specified and maintained. On the vast majority of jobs, however, insistence on extremely fine limits is a vice of the worst order, for it involves reduction in output, waste of time, labour and material through excessive rejections, and unnecessary stoppage of machines for re-grinding and resetting tools. It is the last split-thousandth that costs the money. I hope no one will jump to the conclusion that I am advocating poor work or bad fits; quite the contrary. But long experience has shown that more trouble arises in many classes of work through fits being too tight rather than too slack. Tight fits involve unnecessary fitting, difficulties in lubrication, and consequent seizing up. Most mechanisms function to full efficiency only after they have been 'run in,' and running in means, among other things, getting rid of unreasonably fine limits. It is elementary, of course, that limits must not overlap, and with interchangeable work the largest shaft must always enter the smallest hole. In this connection a great responsibility rests on designers, some of whom are apt to tackle the problem by asking themselves 'What are the finest limits that can be attained?' instead of facing the real question, which is, 'What are the widest limits that can be allowed without detriment to the satisfactory functioning of the finished job?' At a time when increased production is the first essential, it is the duty of every responsible designer to face this question of limits with courage and common sense. I am confident there are thousands of jobs now being done in which limits might be increased and much larger output attained without any sacrifice of ultimate efficiency."

## Books of Reference

*Oil and Petroleum Year Book*, 1942. London: Walter E. Skinner, 20, Copthall Avenue, E.C.2. Price 10s. net.—In the new edition of this book, complete and up-to-date particulars are given of 514 companies covering all branches of the oil industry. The many changes which have taken place throughout the industry are recorded. The directory of makers of oilfield and refinery equipment has been compiled with care and is another section which will increase the usefulness of the book.

*The Colliery Year Book and Coal Trades Directory*, 1942. London: Louis Cassier Company, Ltd., 22, Henrietta Street, W.C.2. Price 21s. net.—The twentieth edition of this reference book will prove as serviceable as its predecessors to all sections of the coal and colliery industries. The directory section includes particulars of the Mines Department, colliery owners, electricity and gas undertakings, and coal merchants. Other noteworthy sections are those covering mines, regulations, statistical tables, and a bibliography of periodical literature.

*"The Shipping World" Year Book*, 1942. Edited by Sir Archibald Hurd. London: *The Shipping World*, Effingham House, Arundel Street, W.C.2. Price 25s.—Under war conditions the production of this reference book has become very difficult, for conditions in the shipping industry have changed much and almost every important port in the world has been affected by the war. The fifty-sixth edition of this year book contains, however, a large amount of valuable information, including lists of shipowners, shipbuilders and ship repairers; a useful "Who's Who" section, and well-classified particulars of British and foreign ports.

SWEDISH SHALE OIL PRODUCTION TO AUGMENT SUPPLY.—Tests on a small scale have been going on in Sweden for some time with the production of shale oil by heating the shale beds by means of electricity by a system invented by a Swedish engineer, F. Ljungström. According to a recent statement by the head of the Swedish State Shale Oil Company, which is carrying on the tests, it seems as if the method would fulfil expectations. So far about 75 cubic metres of oil have been obtained direct from the shale rock. The company is now ready to start trial production on a larger scale, expected to yield about 5000 tons a year, corresponding to about the capacity of one furnace by the earlier extracting methods. The scarcity of oil, caused by the practically entirely stopped imports, has prompted Sweden to enlarge her domestic production of shale oil in order to help to cover her most urgent needs. The output, which earlier was insignificant and which from a purely economic point of view hardly pays in normal times, has been enlarged by the establishment of an entirely new plant with a capacity of some 30,000 tons a year. In addition, the shale oil plant of the Swedish Navy has been considerably extended. The Swedish shale deposits have a rather low oil content—only 5 to 7 per cent., compared with up to 20 per cent. in certain other countries—and considerable quantities of shale must be quarried for every ton of oil. In the new plant recently completed the furnaces have to be fed with about 2000 tons of shale a day, corresponding to the mining of 2400 tons of shale rock, in order to produce the estimated annual quantity of 30,000 tons of oil.

# The Engineer

*SEPTEMBER 25, 1942*

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## Contents


THE ENGINEER, September 25th, 1942 PAGE

A SEVEN-DAY JOURNAL ... 247

LEADING ARTICLES—
SPEED AND CONVOY ... 258
THE SCRAP DRIVE ... 258

SPECIAL ARTICLES—
AIR POWER ... 259
CANADIAN LOCOMOTIVE EXPERIENCES. No. IV ... 250
DELAWARE AQUEDUCT. No. IV. (Illus.) ... 248
MERCHANT MARINE ... 253
SIR CHARLES PARSONS AND MECHANICAL GEARING. No. II. (Illus.) ... 261

ARC WELDING AND WAR PRODUCTION. No. I. (Illus.) 255
FEN FLOOD PROTECTION. No. III. (Illus.) ... 254
PLASTICS IN AIRCRAFT CONSTRUCTION. No. II ... 265
RUBBER MOULDINGS WITH FELT CORES. (Illus.) 264
UNREASONABLY FINE LIMITS ... 257
WELDED AMERICAN TANKS. (Illus.) ... 264

LETTERS TO THE EDITOR—
FUEL ECONOMY ... 260
FUEL WASTE—SUMMERTIME ... 260
MECHANICAL DRAWINGS ... 260
EDUCATION AND THE WAR EFFORT ... 260
HIGH-SPEED STEEL SHORTAGE ... 260

NEWS AND NOTES—
BOOKS OF REFERENCE ... 257
BRITISH STANDARDS INSTITUTION ... 266
FORTHCOMING ENGAGEMENTS ... 268
MARKETS, NOTES AND NEWS ... 267
NOTES AND MEMORANDA ... 268
SIXTY YEARS AGO ... 257



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## SPEED AND CONVOY

AMONG laymen there has been a tendency at times during the war to question the effectiveness of the convoy system as a protective measure for shipping, and to advocate the building of faster cargo vessels, which, it is supposed, would be able, by reason of their speed, to evade submarine attack. The point was raised again the other day in the House of Commons when the First Lord of the Admiralty was asked "why he was content with a speed of 10 knots" for the 10,000-ton vessels now under construction. Mr. Alexander, in reply, pointed out that the designed speed of the ships was 11 to 12 knots, and that they were found to be the most economical in material, in man power, and in carrying capacity. He might have gone a step further and reminded his questioner that a great proportion of our pre-war shipping was made up of vessels not exceeding 12 knots, and since all these would have to be fitted in with faster ships in convoys the extra knots of the newer ships would be unused except when proceeding individually, as from dispersal points. The convoy system does provide for what are known as high-speed convoys, but a maximum of 12½ knots is understood to be the general rule in these. Normal ocean-going convoys are expected to average 240 sea miles per day. A fundamental reorganisation of the whole system would be necessary if there were any large-scale addition to our carrying strength of vessels designed to do 15 knots or more. Another point which the advocates of greater horsepower and speed overlook is the inevitable slowing down of output. An engine works which can deliver machinery for 100 vessels of 10 knots would probably reduce its output to between 50 and 70 sets of engines per year if the designed speed were 15 knots. In these days of fuel economy, with a shortage of coal threatened at the immense figure of 13,000,000 tons, the increased consumption in the faster ships would be a grave disadvantage. The same argument applies in the case of oil-engined ships. The oil problem is just as grave as the coal problem.

The contention that ships of more than 15 knots speed can evade submarine attack cannot be maintained in face of practical experience in the course of the war. After the fall of France the British Navy was so severely denuded of escort vessels, owing to damage in the Channel fighting, that as an emergency measure vessels of 18 knots and more were allowed to proceed independently, since it was impossible to maintain at that moment the full quota of inward and outward convoys. Those connected with shipping are well aware of the large number of those ships then sailing individually which were destroyed by submarine attack. In the later months of 1940 the monthly total of tonnage lost was treble the average of the spring months, and a great proportion of that increase was among unescorted ships of considerable size. If any proof were needed that high speed in itself is not a safeguard, the torpedoing of the "Lusitania" in the last war should provide it. It is no answer that other high-speed vessels, like the "Olympic" and "Aquitania," sailed as single units when transporting the American Expeditionary Force. They were always met by a destroyer escort on arrival in what was then the submarine danger zone. To-day that danger zone is not limited to focal areas. The U-boats are operating at far greater distances and in much more widely scattered areas than they did in 1917, and no stretch of ocean can now be classified as free from danger. Plenty of naval officers in the early stages of this war were inclined to question the utility of the convoy system. The objections to it are well known, and if any other form of coverage for shipborne cargoes had shown reasonably satisfactory results, the Navy would have welcomed the release from escort work quite as gladly as anyone in the shipping world. But every naval officer who was brought into close contact with the commerce-destroying campaign became convinced that convoy was the only effective protection, and that no other of the many suggested schemes would keep the loss ratio down, as convoy did, to one loss in every 200 ships moving under escort. Incidentally it may be noted that the distance steamed by ships in convoy since the war began is 125,000,000 miles. It is an indication of the effectiveness of convoy in countering the enemy's tactics that the Germans found themselves driven to the development of the "wolf-pack attack." In order to achieve any results at all against convoys they had to concentrate flotillas. The immediate result was that the rate of loss among U-boats rose. Admiralty bulletins on more than one occasion have recorded the sinking of at least three attacking craft in one day in the course of such wolf-pack operations. When America was forced into hostilities last winter the German Submarine Command seized upon the opportunity to throw the whole weight of their attack against those northbound and southbound routes on the American side of the Atlantic in which they knew that convoy had not been the practice. They achieved considerable results for some weeks until the very complicated organisation of convoy on those routes was brought into working order. Since June losses of tonnage in that area have diminished, while at the same time losses of U-boats have risen to totals hitherto untouched in any two months of the war.

It is a fact too little recognised that four successive concentrations of effort have been thrown against our convoys by the enemy, and four times those attacks have been broken, leaving our seaborne commerce proceeding, not unharmed, but uninterrupted. That fact ought to be recognised, for it is a clear justification of the convoy system. Without it there can be no question that our total loss of tonnage would be much nearer to the twenty millions that Dr. Goebbels imagines it to be, and the position of the United Nations would be infinitely graver than it, in fact, is.

### The Scrap Drive.

THE Ministry of Works and Planning has made a further move in the drive to obtain adequate scrap supplies for the iron and steel industry, and all occupiers of premises in England, Scotland, and Wales, on which there are 3 or more tons of metal suitable for scrap, have to inform the Ministry by October 21st. This Order applies to any metal, either ferrous or non-ferrous, other than aluminium, magnesium, or their alloys, "which is or forms part of any building, structure, plant, or article which is disused, obsolete, or redundant or otherwise serving no useful purpose," and the premises under the Order includes any building or land having an assessment under Schedule A or subject to a valuation for rating.

This Order is really an extension of a previous Order applying to certain districts of the country. It calls for a report of loose scrap; fixed scrap, such as machinery, plant, &c., and reserve or standby plant. But there is no intention to take as scrap valuable machinery and plant or any machinery

belonging to firms that have closed down under one of the various official concentration schemes. At the same time, owners of plant unwilling to part with their machinery, &c., have a right to appeal. On the face of it, it would appear that no individual or industry is likely to suffer hardship through the provisions of the Order, and there is a possibility that the country may benefit considerably from the information which will come into the hands of the authorities. There is no doubt that the various drives to obtain metal scrap, certain descriptions of which are probably more urgently needed now than at any time, have been of incalculable benefit to the country by providing the means of maintaining our iron and steel production. It is doubtful, however, if all the sources from which scrap can be obtained have been tapped. For instance, in the more remote country districts of Great Britain there are unexplored possibilities. On most farms disused agricultural plant is to be found. The Order, no doubt, covers even the most remote farm in the country, but the 3-ton limit (which restricts the operation of the Order) may result in much useful scrap remaining undeclared. Remoteness from a central dumping ground and lack of organisation in rural collections has resulted in much material remaining derelict that would be gladly received by the consuming industry. Whilst the majority of farms may not have on hand so large a tonnage as 3 tons of material suitable for scrap, a carefully organised system of collection would be likely to bring to light a large aggregate tonnage from farms and country districts.

The difficulties of scrap collection, particularly in important quantities, are inevitable. They were apparent when an attempt was made to collect the scrap arising from "blitzed" buildings, and eventually a scheme was put into force by which the Ministry of Works and Buildings, the Ministry of Supply, and the London County Council became jointly responsible for the recovery of scrap from the damaged sites, and the Ministry of Transport became the agent of the Ministry of Supply for its removal to sites selected by the British Iron and Steel Corporation, acting for the Iron and Steel Control. Some such scheme should be adopted to deal with the country areas, the principal problem of which is transport, and a systematic canvas of farms and agricultural industries should be carried out, however isolated they may be.

# Air Power

By H. E. WIMPERIS

MANY opinions may be expressed, as indeed they are, on the merits of Major Seversky's striking book "Victory Through Air Power." It challenges opinions now generally accepted in a way that needs to be faced. If he is right, the war can be won by air power alone. His arguments are, however, entirely based on certain quantitative assumptions, of an arresting kind, and the question is whether those assumptions can be correct. If they are not correct, the superstructure built on them collapses, but equally if they are valid, then his arguments must be taken seriously and his conclusions given full weight in the counsels of the nation. Engineers, like the rest of their fellow-citizens, are vitally interested, but they, far more than others, will be able to assess the technicalities on which the arguments are based. It is their field.

Major Seversky comes to grips with his subject in the very first sentence of the American edition of his book: "The most significant single fact about the war now in progress is the emergence of aviation as the paramount and decisive factor in war making." He claims that to-day no land or sea operations are possible without first obtaining control of the air, and that once really long-range aircraft are in existence, there will remain no major tactical task now entrusted to navies which cannot and will not be "swallowed up by aviation." In his view, 5000 bombers of the size of the present 80-ton Douglas "B 19" aeroplane, with an adequate pursuit escort, in the possession of any country would make it the master of any other country within a radius of 3500 miles, since unless the selected victim had an equal or stronger air force, it would be as helpless as were Czechoslovakia or Denmark. It is no doubt true that the air enthusiast, whose predictions before the war we were disposed to discount, has turned out to be a truer prophet than his rivals; not perhaps that he was specially foresighted, but that he happened to "spot a winner" and has consequently no doubt felt the internal warm glow of satisfaction that attends such fortune. Is Major Seversky about to prove an equally successful prophet?

That a large force of land-based aircraft can, within their flying range, deny the safe transit of the seas to naval and other ships is manifest by what happened in the English Channel at the time of the Dunkirk evacuation and more recently in the attack on Dieppe, as well as by events in the Mediterranean and in the South-West Pacific. Major Seversky makes the prediction that within five years around-the-world flights of 25,000 miles without any intermediate landings will be possible; but such distances are not essential to "victory through air power," seeing that a striking radius of some 6000 miles would suffice to bring all the major nations, their capitals and key cities and strategic centres within reach of America or of almost any base anywhere in the world. Action at 6000 miles would mean a total flight of 12,000 miles compared with the pre-war record of 8000 miles—quite a considerable step-up, since any military aircraft would need to carry not merely fuel but bomb load and armament. The question we must examine is whether this distance of 12,000 miles is attainable, either now or in the near future. This, as it happens, can be fairly confidently examined in the light of present-day knowledge. But it should be remembered that even half the flying distance of 12,000 miles would be highly effective if applied in the right place. A radius of action of 3100 miles, for instance, would enable American planes to attack Japan from Alaska without remission, and if enough aircraft were employed on the task the effect on the struggle in the Pacific would be prodigious.

The greatest range attainable by any specific aircraft depends on four factors—the least gliding angle at which the aircraft can fly, the efficiency of the airscrew, the rate of fuel consumption for a given engine power, and the proportion of the initial total weight which can be allocated to the fuel. The altitude of flight does not enter, unless it happens to affect the rate of fuel consumption per horsepower-hour, as it may sometimes do to a secondary extent. Experience, as revealed by published information, shows that a modern bomber can achieve 25 ton-miles per gallon of fuel, and that this figure in some cases rises as high as 30. If we assume that the rate of fuel (and oil) consumption is $\frac{1}{2}$ lb. per horsepower-hour, and that the airscrew efficiency is 80 per cent., this figure of 30 ton-miles corresponds to a gliding angle of 1 in 15, which may therefore be taken to be the best angle of glide in the best bombers about which published information is available. As I show later, this corresponds to a flying distance of 6100 miles, if half the original load is fuel. The Short Bros. flying boat "Golden Hind" showed years ago that this proportion of fuel could be carried.

It can be shown that the figure for ton-miles per gallon is obtainable from the expression

$$\text{Ton-miles per gallon} = 1{\cdot}25\,\frac{a\,b}{c}$$

where $a$ is the aircrew efficiency, $c$ the consumption of fuel in pounds per horsepower-hour, and $1/b$ is the best gliding angle. From this it follows that the distance that can be flown is given by

$$\text{Distance in miles} = 375\,\frac{a\,b}{c}\,\log_e\frac{W}{W-F}$$

where W and F are the initial weights of the aircraft and fuel respectively. And from these one has the useful relationship that the ratio of the distance that can be flown to the figure of ton-miles to the gallon is given by the simple expression

$$700\,\log_{10}\frac{W}{W-F}.$$

Major Seversky speaks of a rate of fuel consumption as low as 0·35 lb. as being attainable. Let us suppose it is, and even assume that it includes the oil consumption also; assume also that the airscrew efficiency can be increased from 0·80 to 0·85, and that the gliding angle can in some way, possibly yet undiscovered, be increased from 1 in 15 to 1 in 20. In these favourable conditions the aircraft performance would rise from 30 ton-miles per gallon to 60, and this would double the range attainable. This figure of 60 ton-miles per gallon can be shown by the above formula to correspond to a flying distance of 12,600 miles, or over half the way round the world. The assumption has been made in this calculation that the weight of the structure, the power plant, instruments, and the crew can all be got within the figure of 50 per cent. of the total initial weight, and that the rest is fuel. One must, however, make allowance for a bomb load. If this amounts to 10 per cent., there would be 40 per cent. for fuel, and the resulting range, allowing for the bombs being taken for half the journey only, would be about 10,000 miles, whilst an increase in this range would result if the bomber were designed for "assisted take-off."

On the whole, it may be said that calculation shows that Major Seversky's total range figure of 12,000 miles can just be attained once the gliding angle, the airscrew efficiency, and the fuel economy figures have been improved to the extent suggested, though for any bomb load to be carried still greater technical improvements would be needful.

There is, it is true, another means of approach to long range, and that is by such a

reduction in structure weight—say, by the discovery of some new very light alloy—as would lead to a substantial saving in structure weight, and so permit a greater load of fuel to be carried. But the prospect of this happening is probably rather more remote than that of the alternatives previously discussed. On the whole, therefore, the chief work to be done is the reduction of drag and the improvement of engine efficiency. Relf, in his 1936 James Forrest Lecture, estimated that if the air flow could be caused to be laminar over the whole "wetted area" the drag would be reduced by no less than 90 per cent.!

What may one conclude from this examination of the situation to-day and the probable situation to-morrow—besides that in the years to come, during which, if Lord Hankey's warning is valid, the war may still be continuing?

At the moment bombers can certainly be built to fly 30 ton-miles to the gallon of fuel. This, if half the initial weight be fuel, gives a total flying distance of 6100 miles without bombs. One may therefore say with confidence that very little cleaning up in design will enable bombers to be produced capable of a double journey of 3000 miles, and therefore of attacking Japan from the American mainland in Alaska. To attain double this total flying distance, *i.e.*, half way round the world, would, as I have said, require an increase in airscrew efficiency which, with contra-rotation propellers, would be possible. It would also require an addition to the streamline perfection of the external design; this is difficult, but may not prove impossible. It requires also that the specific fuel consumption shall be substantially decreased; this will be the hardest to attain. Some abatement in such severe requirements would follow if new materials or methods of construction or use permitted the bomb load to rise above the proportion of one half the initial laden weight of the aeroplane. It looks as though Major Seversky thinks it could, since, towards the close of his book, he forecasts a Glenn Martin bomber weighing 250,000 lb. and capable of carrying 80 tons of bombs or cargo to Europe; but I do not know of any evidence that such a craft is really possible, and one cannot therefore base any argument upon it—though, if one could, it would no doubt go a long way to buttress the largest of Major Seversky's claims. Perhaps he really intended to refer to the projected "500,000 lb. ship."

To sum up, one can say that at the present time with a very modest advance in aircraft design, one half of Major Seversky's claim for a striking radius of 6000 miles can be achieved, and that the balance may not be far off. What is certain is that the longer the war lasts, the more potent a weapon does the aeroplane become, whilst the room for its technical improvement shows little sign indeed of being at all cramped.

Major Seversky is a leading aircraft designer in the United States, and much of his book is devoted to domestic problems in that country. The challenge he has thrown down will no doubt be eagerly canvassed in his own country, and since America is a great manufacturing centre for heavy bombers for the United Nations, we may expect that any fruition that this book may bear will be gladly and rapidly harvested by our American Allies to their own great advantage and ours.

# Letters to the Editor

*(We do not hold ourselves responsible for the opinions of our correspondents)*

## FUEL ECONOMY

SIR,—When a real emergency forces us to look into our affairs from a new angle, it is surprising how often we find that economies, which would not have been thought practicable in normal conditions, can be made. As an example, we have been using large quantities of gas for heat treating a certain class of steel, of which our consumption was considerable. Under pressure of circumstances we have decided to discontinue the heat treatment of this particular steel, with a consequent saving of 128,000 cubic feet of gas per week, in addition to a weekly saving of something like £18 in labour cost. While this has resulted in some slight decrease in the physical quality of the steel, we do not consider that this is serious enough to justify us in continuing the process, at all events till the fuel situation improves.

Another economy has been made by abandoning the annealing of certain castings, as we find that the introduction of Ardoloy cutting tools makes it unnecessary. Probably the most important economy of all can be made by a slight reduction in the temperature of works and offices throughout the winter months. During recent years there has been a tendency to increase these temperatures to some extent, possibly under the stimulus of the American system of standardising gauges at a temperature of 68 deg. I am convinced that this temperature is far in excess of what is either necessary or desirable from a health point of view. I believe the temperature of our offices could well be reduced to 60 deg. and our shops to about 55 deg. When a man is working in an unduly heated atmosphere his skin becomes moist and sudden exposure to a bitter wind outside involves very considerable danger of chill. A reduction such as I have suggested of working temperatures throughout the country would undoubtedly effect a really important economy.

ALFRED HERBERT.

Coventry, September 13th.

## FUEL WASTE—SUMMER TIME

SIR,—The idea that fuel is saved by "summer time" is a fallacy. On the contrary, it—especially "double summer time"—causes waste of fuel, *i.e.*, its use to supplement day warmth. The "thermal noon of clear weather" is, on the average, about 2 p.m. (G.M.T.), which is why, symmetrically, the traditional day out of bed is 6 a.m. to 10 p.m. (G.M.T.). In the seasons in which, in spring and autumn, when thermal noon is just about 2 p.m., fires or heaters are often just not needed on mornings starting at 6 (G.M.T.), but they are often needed on mornings starting at 4 (G.M.T.), as last spring, or 5, as in the next few weeks. It is one thing to stand the cold for one hour, until it begins to get warmer, and quite another thing to stand the cold for three hours. A little reflection will show that any balancing gain—saving of fuel—in the evenings is small in comparison. As to light, a 60-watt lamp—40-watt would do if shades were discarded—lights a fair-sized room. A 600-watt heater takes hours to raise the temperature of a small room 3 deg. I roughly estimate that 500,000 tons of coal a year is wasted by summer time and double summer time.

R. A. RYVES.

Harlow, September 21st.

## MECHANICAL DRAWINGS

SIR,—It would be interesting to know if all directors and works managers of engineering works are aware of the fact that if through enemy action mechanical drawings (original or otherwise) are destroyed, no compensation will be paid under the War Damage Act, 1941, Part II, owing to such drawings being classified by the Board of Trade as "documents owned for the purpose of a business." Under Section 95 of the War Damage Act, 1941, documents cannot be included with "goods" under Part II of this Act for compensation.

As mechanical drawings are the genesis of any engineering works, surely a great injustice is being done to firms who unfortunately have lost their drawings through enemy action.

Would it not be possible for the trade to get this injustice remedied by representation to Parliament, as until the Act is amended I understand that the Board of Trade are powerless to alter this decision. In many cases the loss incurred runs into many thousands of pounds. No doubt many of your readers can confirm these facts. I understand that this ruling also applies to architectural drawings.

A. C. S. B.

Salfords, September 18th.

## EDUCATION AND THE WAR EFFORT

SIR,—May I draw Mr. F. L. Mayer's attention to the fact that an association such as he suggests is already in existence and would, I am sure, welcome any assistance he could give? I refer to the Association of Scientific Workers (73, High Holborn, W.C.1), which is open to engineers and other scientists. One of its main objects is to work for the most effective use of science and scientific method in the welfare of society as a whole and particularly in its application to the present war effort. As one step towards this end, a conference is to be held on September 27th in Manchester, the subjects for the two sessions being "The Place of Science in the National Effort" and "Science and Production in the North-West."

W. F. DEAN, B.Sc., A.I.R.I.

Liverpool, September 19th.

## HIGH-SPEED STEEL SHORTAGE

SIR,—In your issue of September 11th, Mr. Yates mentioned that he has had better results from high-speed tools with butt-welded tips than from solid tools and invites an explanation. May I point out that the issue is wider than Mr. Yates appears to visualise?

High-speed steel should give a minimum Rockwell "C" hardness of 64. In the last few months I have seen tools, hardened by prominent engineering concerns, with brazed tips, with butt-welded tips, and solid, all alike giving readings little higher than 50. The all-in cost to a concern of tools not being fully hardened must be material, and under war conditions it is intolerable. Obviously, no works should undertake hardening unless it possesses or has access to a suitable testing machine.

It is my conviction that inquiry would show that the authorities would be justified in making it an offence at the present time to use any untested high-speed cutting tool.

S. F. BARCLAY, D.Sc.

Sale, September 22nd.

# Sir Charles Parsons and Mechanical Gearing*

By S. F. DOREY, D.Sc., Wh.Ex.

No. II—(*Continued from page 241, September 18th*)

FIG. 2 shows details of the first gear hobbing machine fitted with a creeping table developed by Parsons and his colleagues. In this machine the work table is given an advance of 1 per cent. in relation to the worm wheel, there being 160 teeth in the worm wheel. This resulted in (160–1·616) cycles of worm error being registered round each complete feed spiral, the fractional part of this number, viz., 0·384, giving the change in phase at any tooth space after the completion of a feed spiral. The feed spiral had a lead of only 1/20in., and it is obvious, therefore, that the rapidly changing phase of the worm error for an advance of only 1/20in. axially down the gear results in successive hob cuts, after each revolution of the work, reducing the magnitude of the worm error undulation. Parsons showed that with the above ratio of change of phase of the error the resultant undulation amounted to only one-fifth of that without the creeping table. It is evident, therefore, that to gain the full advantage of the creep principle, attention should be paid to the choice of the best ratio for the phase change per creep spiral. This has been mentioned because in recent years creep machines have been made in which the number of cycles of error per revolution of the work has given an integer—see Fig. 1*c* (*ante*). With such an arrangement one of the primary advantages of the creep mechanism, namely, the placing of the worm error spirally round the gear and the reduction of the magnitude of the error to about one-fifth, is lost.

Parsons stated, subsequent to the adoption of the 1 per cent. creep arrangement, that "5 per cent. creep is better, for it destroys a long periodicity across the face of the wheel, which, with narrow wheels, may cause a certain amount of vibration." No doubt the periodicity referred to was that due to the worm wheel cumulative error. This periodic is very difficult to eliminate, because of the difficulty of removing a cumulative error from a large worm wheel or internal creep wheel. It results in the formation of the well-known creep markings on the gear. With 1 per cent. creep the phase shift of the cumulative error is 0·01 time the pitch circle circumference, and the feed advances $f$ across the gear, where $f$ is the feed per revolution of the work. When the phase has moved an amount equal to the pitch circle circumference, the feed will have advanced an amount equal to the lead of the creep spiral, *i.e.*, $100 \times f$ for 1 per cent. creep. Fig. 3*a* shows the form and phase change of the undulation due to the cumulative error. It has been calculated for a case having the following particulars, viz.:—

*Pinion: p.c.d.*—27·63in., normal pitch 7/12in., number of teeth forty-one, face width 6in., spiral angle 30 deg., $f$—1/20in.

It will be noted that the periodic causes an undulation 5·77in. in length along the tooth space. With 5 per cent. creep the lead of the creep spiral becomes $20 \times f$ and the form of the undulation is shown by Fig. 3*b*. This diagram indicates a much smaller length of undulation, viz., 1·155in., and this was found by Parsons to be better than that shown by Fig. 3*a*, in the case of a gear wheel having a narrow face.

There is another interesting point regarding Fig. 3*a* and *b*; the lines A B and C D join points in the undulations 180 deg. out of phase respectively in adjoining tooth spaces It will be noted that these lines are nearly parallel with the axis of the gear. In Fig. 3*c* the lead of the creep spiral has been made equal to the axial pitch of the gear with the result that lines A B and C D are in fact parallel with the axis of the gear. The pattern of this undulation, as far as axial planes are concerned, should be compared with that of Fig. 3*d* for a gear cut on a solid table machine. It will be noted that in both cases the undulations are all in phase with one another as they run into mesh, such an arrangement causing periodic movements, both torsional and axial, as the gear runs into mesh, with noise corresponding to the frequency of meshing of the undulations. In Fig. 3*e* the lead of the creep spiral has been made equal to twice the axial pitch and coaxial planes now link up undulations alternately 180 deg. out of phase with one another. So far as uniform motion of the gear wheel is concerned, this arrangement is ideal provided the full width of the gear is not too small. From the foregoing it is obvious that the creep arrangement requires very careful consideration, and for a particular gear to be cut the value of the feed $f$ might be considered so as to avoid as far as possible the condition indicated by Fig. 3*c*. Furthermore, the creep ratio should be such as to reduce the magnitude of the worm error by arranging a large phase shift of the error at the completion of each feed spiral. Although this was pointed out by Parsons in 1913, many creep machines have been made since that date in which the creep ratio is such that a whole number of periods of worm error are registered round the gear wheel during one revolution of the work.

So far as gear noise is concerned, the danger of resonance has already been indicated; this should be considered in the design of double helical gearing by maintaining a stiff construction, both torsional and axial, between the two helices of the gear. Fig. 4 shows the torsional and axial vibration of a single helical gear, rigidly coupled, and having an undulation along the tooth spaces which ran into mesh at a frequency equal to an axial natural frequency of the system. This set up both torsional and axial movements of the gear which were exactly equal

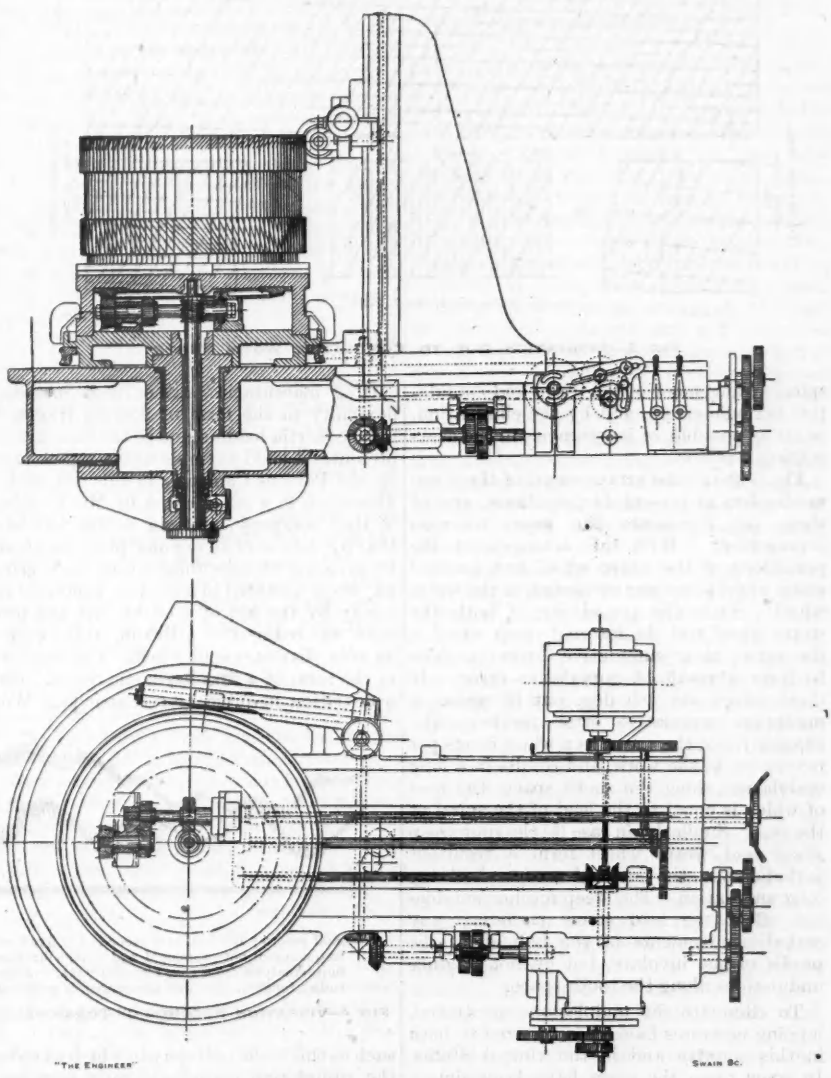



FIG. 2—FIRST GEAR HOBBING MACHINE WITH CREEPING TABLE

* The Institute of Marine Engineers. The Parsons Memorial Lecture, 1942.

to the fundamental frequency in the noise analysis from the gear. This certainly illustrates how right Parsons was in adhering to the principle of the fitting of flexible couplings between the pinion and turbine, and maintaining maximum stiffness otherwise in the construction of the gears and casing, as opposed to flexible mountings advocated elsewhere. It seems, too, that much can be done to improve present-day creep machines by adhering to principles explained by Parsons in 1913, namely, that of the correct spiral arrangement of the worm and cumulative periodic errors, and by the elimination, as far as possible, of inaccuracies in the gear-cutting machine.

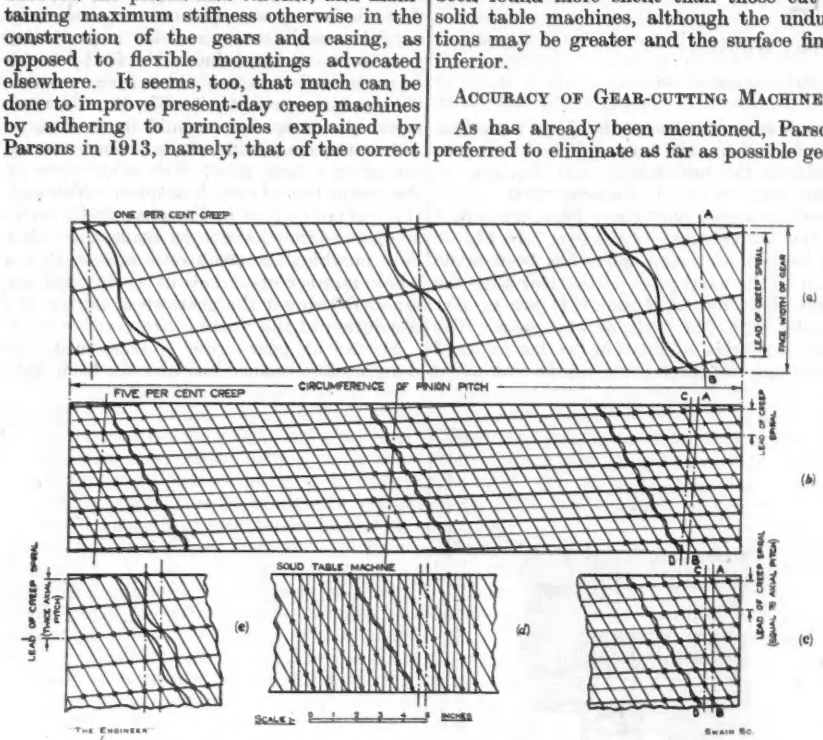



FIG. 3—UNDULATION DUE TO CUMULATIVE WORM ERROR

Fig. 5 shows the arrangement of the creep mechanism in present-day machines, and of these (*a*) represents the more common arrangement. With this arrangement the periodicity of the worm wheel and internal creep wheel is one per revolution of the worm wheel. Since the periodicity of both the worm wheel and the internal creep wheel is the same, their cumulative errors combine to form a resultant cumulative error. If these errors are 180 deg. out of phase, a minimum cumulative error results. The cumulative of the spur creep wheel is one per revolution of the work, and results in a long undulation along the tooth space, the lead of which is equal to the lead of the spiral of the gear. Similarly, in case (*b*) the spur creep wheel and worm wheel form a resultant periodic, and the internal creep wheel the long undulation. The creep mechanism does not affect the lead screw periodic; any periodic movements of the hob affect the profile of the involute, but do not produce undulations along the tooth space.

To eliminate the undulations mentioned, lapping processes have been resorted to both in this country and in the United States. In some cases the gears have been simply meshed and run with a light load using glass powder as a grinding medium. Since tooth action includes both rolling and sliding contact, care has to be exercised to avoid destroying the involute profile.

There seems little doubt that for increased load and reduced weight of gear for a given power transmission, undulations must be removed or in any case reduced, otherwise excessive surface stresses will result. Further, lubrication difficulties will be increased with increase of load unless undulations are eliminated and surface finish improved. Whether solid-table or creep machines will succeed in producing the best gears in the future is an open question, but at present, as already mentioned, creep cut gears generally have been found more silent than those cut on solid table machines, although the undulations may be greater and the surface finish inferior.

### ACCURACY OF GEAR-CUTTING MACHINES

As has already been mentioned, Parsons preferred to eliminate as far as possible gear-cutting inaccuracies, rather than introduce flexibility in the form of floating frames to reduce inertia loading due to the inaccuracies present. A good example of the attack made by the Parsons Company in this direction is illustrated in a paper given by Mr. Douglas‡ of that company, wherein it was indicated that by the use of an angular pitch gauge and by grinding of individual errors, by a grinding wheel mounted in a slotting machine, and finally by the use of a crown lap, the pitch error was reduced to 1/1000in. in the case of an 80in. diameter spur wheel. The error was in the form of a first harmonic due to either a deviation in pitch or eccentricity. Work such as this is the only way in which to reduce the cumulative periodic already mentioned for the case of creep machines.

The Parsons Company also arranged their gear-cutting machines in one shop with temperature control, so that diurnal errors could be obviated. In the early days of hobbed gears, the hob itself introduced errors which affected the form of the involute.

### LUBRICATION

In 1916 H. M. Martin§ applied Osborne Reynolds' theory of lubrication to mechanical gearing and his analysis is worthy of careful study. The following relationship was obtained, viz.:—

$$p \propto \frac{u_o \sqrt{R}}{h_o^{1.5}}$$

Where R=the mean radius of curvature of the pinion teeth.
$u_o$=mean linear velocity of rolling.
$h_o$=minimum film thickness.
$p$=maximum pressure in the oil film.

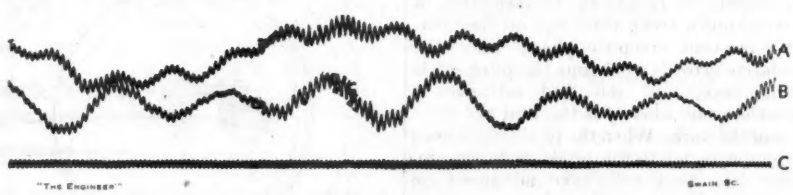
This relationship is important because R is proportional to the pinion p.c.d. for a given ratio of addendum to dedendum, and for a given pressure angle. Further, $p$ is proportional to the load P, which can be carried per inch face width. It is thus seen that for a given value of the film thickness the permissible value of P will vary as the square root of the p.c.d. Martin applied his results to a pinion having the following particulars, viz.:—

| | |
|---|---|
| Pitch circle diameter ... ... ... | 14in. |
| Pitch line speed ... ... ... ... | 62ft. per second |
| Pitch ... ... ... ... ... ... | 0·822in. |
| Helix angle ... ... ... ... ... | 45 deg. |
| Load per inch face width ... ... | 520 lb. |
| Load per lineal inch ... ... ... | 267 lb. |

The oil film thickness was calculated at 0·000125in., maximum oil pressure 6376 lb., and the width of the bearing pressure zone 0·0866in. In making these calculations the temperature of the lubricating oil was taken at 90–100 deg. Fah., with a viscosity of 0·7 dynes per square centimetre.

As the amount of the addendum of the pinion is increased, the curvature of the pinion becomes less sharp; that is, the value of R in the above equation increases, as does the value of $u_o$. The permissible value of P is thus increased for a given value of film thickness. Theoretically therefore an increase in the ratio addendum to dedendum permits a higher load from considerations of lubrication. As will be seen later, it also brings about a reduction of the surface stress. Parsons took advantage of this by introducing all-addendum pinions in 1932, and proved by experiment that an increase in load was possible. This led in some cases to the elimination of the centre pinion bearing, which had been provided from considerations of lateral stiffness where the axial length over the gear face exceeded three times the pinion p.c.d. The consequent saving in weight was very great. However, the velocity of sliding during the meshing of teeth was considerably increased, and in the case of small pinions "scuffing" of the gear occurred. This so-called "scuffing" is a result of seizure of the tooth surfaces, and a consequent tearing away of the material.

The analysis by Martin does not take into account the velocity of sliding; however, with an all-addendum pinion the unidirectional sliding should serve to increase the drag which draws the oil into the region of high pressure, resulting theoretically in improving oil film lubrication. In this respect it may be mentioned that with an all-addendum pinion the sliding velocity is




A=axial record; B=torsional record; C=fixed vibrator. The record was taken with a Sperry M.I.T. set; frequency of both torsional and axial vibration approximately 400 v.p.s.; frequency of fundamental in noise analysis from gear also 400 v.p.s.; range of axial movement of pinion $^{7}/_{1000}$in. at maximum amplitude; range of torsional movement of pinion 0·0095 deg. at maximum amplitude.

FIG. 4—VIBRATION RECORDS OF TORSIONAL AND AXIAL MOVEMENT OF SINGLE HELICAL PINION

‡ "Mechanical Gearing for Large Power Tranamission," by L. M. Douglas. "Trans.," N.E. Coast Inst. of Engineers and Shipbuilders, December, 1940.
§ See *Engineering*, August 11th, 1916.

sufficient for the formation of an oil film at normal running speeds, if the temperature rise in the oil film above that of the oil circuit is taken to be only of the order of several degrees, as considered probable by Osborne Reynolds. Furthermore, so far as the oil film formed by the sliding velocity is concerned, its thickness or load-carrying capacity will vary as $d$, the pitch circle diameter, instead of $\sqrt{d}$ for rolling contact. It is interesting, however, to consider the calculated film thickness, viz., 0·000125in. in conjunction with the phenomenon of "scuffing." The small magnitude of the film thickness would demand a high degree of surface finish for film lubrication to be the only governing factor. Undulations, cusps, and facets present in a new gear would suggest that in the first hours of operation abrasion occurs. Under these conditions of surface imperfection, pure rolling contact seems preferable to sliding, and no doubt the increased sliding velocity with an all-addendum pinion results in "scuffing," whereas otherwise pitting might or might not occur. On the other hand, once the tooth flanks have obtained that polished mirror-like surface after a period of operation, there seems little doubt, as Parsons showed, that both from a point of view of surface stress and lubrication, the A.A. pinion teeth having less sharp curvature

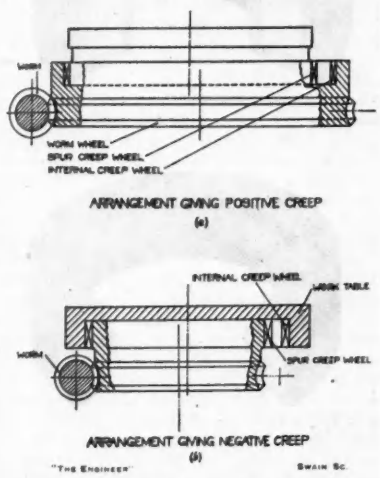



**FIG. 5—CREEP ARRANGEMENT IN GEAR-CUTTING MACHINES**

will successfully withstand an increase of load, as compared with the pinion having the normal ratio of addendum to dedendum. Messrs. Parsons insist on the lapping of all-addendum pinions, and this is probably done to prevent "scuffing" action which would otherwise be likely to occur in the first hours of life of the gear. The theory of oil film lubrication certainly indicates the necessity for a running-in period for a gear before fully loading it. Until this running period is successfully bridged, oil film lubrication is not fully applicable, nor are the advantages accruing from the all-addendum gear.

Increased pressure angle from, say, 14½ deg. to 22½ deg., also increases both the mean radius of curvature of the pinion tooth profile, and the relative speed of the two surfaces, with increased oil drag. However, the length of the path of contact is reduced.

From the foregoing it is seen how from considerations of oil film lubrication the following relationship is obtained, viz.:—

$$P=K\sqrt{d},$$

where K is a constant and $d$ is the pitch circle diameter, and the speed is taken as approximately constant for marine gears. Parsons adopted this relationship before Martin made his analysis, and the value of K adopted was 180 to 220 for gears for the merchant service and for naval work 200 to 225, and up to 310 with A.A. teeth. A speed factor has so far been omitted. This is probably due to compensating effects, because although an increase in speed increases the possible load for the same oil film thickness, the accelerations and decelerations due to gear-cutting inaccuracies also increase, resulting in an increase of inertia loading.

## GEAR LOADS

As already explained in the section dealing with lubrication, gear loading depends to a large extent on the ability of the gear teeth to maintain oil film lubrication during operation. Regarding the bending stress, Parsons showed that under static conditions a load of 40,000 lb. per inch of face width was required to break the teeth of a 6in. diameter pinion, when meshed with a gear wheel of 26in. diameter, the normal pitch being 7/12in. and the spiral angle 30 deg. This experiment, together with the practice of rounding the bottom of the interspaces between the teeth, certainly eliminated bending fatigue stress as being a controlling factor in gear loading. Furthermore, it is borne out in practice, since only in cases of defective material or excessive resonant vibration has failure occurred by tooth fracture.

Apart from bending stress on the teeth, they are subject to surface stress, and Hertz has shown that the following relationship holds, viz., $P=k\times d$, $k$ being a constant and P and $d$ being, as before, the load per inch width of face and the pitch circle diameter respectively.

$d$ appears in this formula for a similar reason to that for which it appears in that dealing with oil film lubrication, namely, because it directly affects the mean radius of curvature of the profile of the pinion tooth. In the early days, for pinions 10in. in diameter and less, the value of $k$ was taken as 60 to 75 with a view to keeping down the surface stress. Above 10in. diameter the radius of curvature was such that with the increased radius oil film lubrication became the limiting factor rather than surface stress, and, as already mentioned in dealing with lubrication, the gear size was calculated, using the formula

$$P=K\sqrt{d}$$

where K had the values 180 to 220 for gears for the merchant service and 200 to 225 for naval work, and up to 310 with A.A. teeth.

With all-addendum pinions it is clear from Hertz's work that the surface stress is considerably reduced, and it is of interest to note that the value of $k$ in the formula $P=k\times d$ has in some cases reached about 120 for pinions of about 5in. pitch circle diameter.

## GENERAL

In the early gears Parsons used 7/12in. and 1in. lead hobs for the first and second reduction gears respectively, and these leads are in very common use to-day for the production of marine gears. The largest gear ratio used by Parsons was 26 : 1 in the case of the s.s. "Cairnross" fitted with single-reduction gears. In naval practice gear ratios of single reduction vary from about 5 to 13, whilst for the early merchant vessels fitted with single-reduction gearing the ratio varied from about 14 to 20. In the case of double-reduction gears, the first-reduction ratio at the high-pressure and low-pressure pinions was about 8 and 6 respectively, and the second-reduction ratio about 6 to 1. The general practice is to balance pinions over 6in. diameter dynamically and the wheels statically. The necessity for good balance is obvious from considerations of satisfactory meshing of the gear teeth.

At the ends of the tooth faces the teeth are relieved so as to prevent excessive local stress at the root section. To do this the teeth are cut back at an angle of 45 deg. to the pitch line, and are further tapered on each side of the tooth to an extent of 30/1000in. to nothing at a distance of ⅜in. from the top of the tooth.

Backlash is also allowed between the engaging gears, and this is sufficient to allow for differences of temperature between the gear case and the gear wheels. Such clearance is generally determined by measuring the axial "float" of the pinion shaft. Typical values for this axial clearance are as follows, viz.:—

| | |
|---|---|
| *Single-reduction Gearing, 7/12in. Normal Pitch* | |
| Axial float ... ... ... ... | 80–100/1000in. |
| *Double-reduction Gearing, 7/12in. Normal Pitch throughout, or with 1in. Normal Pitch at Second Reduction* | |
| Total axial float at first reduction pinion, i.e. due to first and second reduction axial floats ... ... ... ... ... | 180–200/1000in. |
| Axial float at second-reduction pinion ... ... ... ... ... | 80–100/1000in. |

Summing up Parsons' work on mechanical gearing, it is of interest to indicate what his work achieved. Not only did it make possible the turbine propulsion of slow-speed merchant ships, but actually increased the power and speed of naval vessels and passenger liners, due to the weight reduction obtained. Further, the application of gearing resulted in considerable saving in steam consumption, because both propeller and turbines could be operated at their most economical speed. Single-reduction gearing showed, in the case of vessels of moderate size and speed, a saving of some 5 lb. of steam per shaft horsepower hour, as compared with direct-turbine drive, whilst the introduction of double-reduction geared turbines showed steam consumption of 10 lb. per shaft horsepower-hour with saturated steam and 8 lb. per shaft horsepower-hour with 200 deg. superheat, giving a fuel economy some 20 per cent. over that obtained with steam reciprocating machinery.

At the time of the first application of mechanised gearing to ship propulsion, both electrical and hydraulic methods of transmission were under consideration, and much time and money was spent in Germany on the development of the latter means of gearing. As has been shown, Parsons' immediate success opened up the almost universal application of mechanical gearing to marine turbine propulsion.

With increased power transmitted and size of gear, machine index errors, however, are correspondingly increased, and it becomes more difficult to eliminate undulations along the tooth space. In paying tribute, therefore, to the magnificent achievements of Parsons, it seems fitting to mention the co-operation and encouragement given by the Engineer-in-Chief's Department of the Admiralty on matters concerning the reduction of gear-cutting inaccuracies. Without such work and endeavour, the powers to-day successfully transmitted through gearing would not have been possible.

Although Parsons' work on mechanical gearing envisaged turbines as the prime mover, there seems little doubt that the future will show it to have a most important bearing on geared oil engine propulsion.

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ESLA BRIDGE COMPLETED.—The bridge constructed to carry the new Zamora-Corunna line over the River Esla in Spain, the construction of which was delayed by the civil war, has been completed. This bridge was described in THE ENGINEER some years ago.

## Welded American Tanks

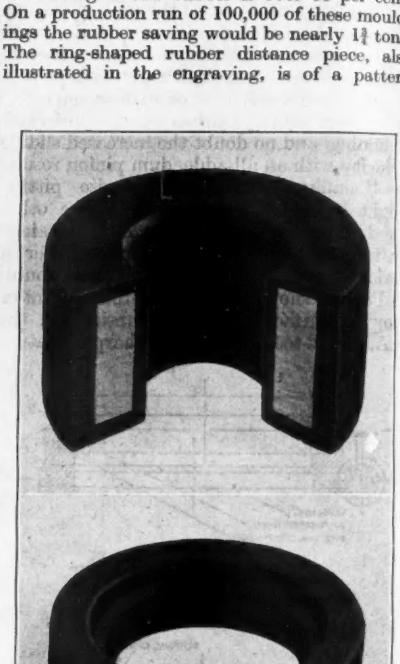
THROUGH the courtesy of the Lincoln Electric Company, Ltd., Welwyn Garden City, we are able to publish the accompanying engravings, released by the United States Office of War Information, of the new "M4," a United States tank. These engravings indicate the progress being made in the United States in fabricating tanks by arc welding. There are two main problems encountered in the successful welding of tanks. First is the metallurgical problem of welding armour plate. Second is the manufacturing problem of providing welding shops with equipment which will permit large tank sub-assemblies to be rotated into different positions, so that joints can be welded in the flat position. Flat welding is quicker and requires less skilled welding operators than welding in the vertical or overhead position. Another photograph received from the Lincoln Company, but unfortunately not suitable for reproduction, shows a very heavy capacity manipulator which will handle an assembly up to about 7 tons. Tank hull members are assembled on these manipulators, and the touch of a switch moves the table of the manipulator and the tank assembly into the position most suitable for fast flat welding.

AMERICAN "M4" WELDED TANK

"M4" TANK AND IN BACKGROUND "M3" TANK

## Rubber Mouldings with Felt Cores

THE name "Relt" has been given to a new product introduced by the Empire Rubber Company, Dunstable, Bedfordshire, in association with the Bury Felt Manufacturing Company, of Bury. It is the product of a new rubber moulding technique, wherein the mouldings consist of a core of felt surrounded by a "corral" of rubber. Among the advantages claimed for these mouldings is the fact that they are from 30 per cent. to 75 per cent. lighter in weight than pure rubber mouldings. The hollow cylindrical moulding, shown in the engraving, measuring 1¾in. deep with an outer diameter of 3¼in. and a bore of 1½in., was originally moulded in a rubber mixture and weighed 2·56 oz. The same moulding produced under the "Relt" process has an inner core consisting of two pieces of felt, 1¼in. deep by 2¾in. outside diameter and 1¾in. bore, and weighs only 1·76 oz. The saving in weight is therefore 32 per cent. Since the raw rubber content of this moulding is now only 0·54 oz., as against the original rubber content of 1·15 oz., the saving of raw rubber is over 53 per cent. On a production run of 100,000 of these mouldings the rubber saving would be nearly 1¾ tons. The ring-shaped rubber distance piece, also illustrated in the engraving, is of a pattern which the Empire Rubber Company previously moulded in rubber in large quantities. Under the "Relt" process this moulding shows a weight reduction from 1·20 oz. to 0·46 oz., representing a saving of 61 per cent., while the amount of raw rubber in the moulding is reduced by 70 per cent. from 0·80 oz. to 0·24 oz.



"RELT" MOULDINGS

Another claim made for "Relt" is that variations in the degree of resilience are more easily secured than with normal rubber mouldings, since the felt core can be provided in a range of different degrees of hardness. "Relt," it is also claimed, opens up new fields for the production of certain types of components, wherein previously, although the desirable qualities of felt were required, it had been impossible to overcome the absorbent nature of this material. By the special union with rubber, however, the felt is now insulated from the effects of damp and the manufacture of a variety of products previously impossible has been facilitated.

A STATESMAN'S MEMORIAL ROAD.—The Quebec Minister of Roads and Public Works has announced that the Highways Department has been authorised to complete the Sir Wilfrid Laurier Boulevard running from Quebec City to Montreal and New York City *vid* the south shore of the St. Lawrence River.

# Plastics in Aircraft Construction*

No. II—(*Continued from page 244, September 18th*)

By GEORGE W. DEBELL

## LIMITATIONS OF EACH TYPE OF MATERIAL

THE limitations of the various types of material from the physical properties standpoint have been adequately covered in the foregoing discussion of the various factors affecting design, but the engineer must also have some knowledge of their limitations from a fabricating or manufacturing standpoint, for if such knowledge is lacking there is always the danger of designing a part that is not capable of being manufactured in existing equipment.

*Limitations of Thermosetting Materials.*—In the case of the laminated thermosetting materials, existing press equipment limits the maximum sizes of flat sheets to approximately 3½ft. by 5½ft., although a few specific manufacturers may have presses that will handle slightly larger sizes. In the case of the formed laminated parts, such as shallow pans and door panels, the maximum sizes are somewhat smaller in order to provide adequate strength in the special dies used in manufacturing this class of product. Usually, formed laminated parts should not be larger than 3ft. by 4ft. if the parts are to come within the capabilities of a majority of the manufacturers. The minimum thickness in which the materials can be fabricated depends largely on the materials used in the laminations. With the heavier weights of fabric, normally known as "C" grade materials, it is inadvisable to use thicknesses less than $\frac{1}{16}$in., as thinner gauges do not have a sufficient number of laminations to provide uniformity in physical characteristics. If a part is to be made thinner than $\frac{1}{16}$in., it is advisable to use lightweight fabric, normally known as "L" grade, in order to avoid the aforementioned difficulty. It is possible to make paper base laminated materials in almost any thickness, but its lower impact strength makes it inadvisable to use this grade of material in thicknesses less than $\frac{1}{16}$in., as the thinner gauges are too subject to accidental damage in handling and service.

In designing parts to be made from high-impact thermosetting materials, the designer should avoid the use of sections thinner than $^5/_{32}$in., even in relatively simple parts, and this minimum should be increased for more complex parts in order to prevent distortion and provide uniformity in physical characteristics. If too thin sections are used, it is difficult to make the high-impact materials flow sufficiently to fill the mould completely, and, even if the mould does fill, there are apt to be large variations in the physical properties due to the resin running ahead of the filler. The lower-impact materials will mould satisfactorily in thinner sections down to as low as $^5/_{64}$in. thickness, but designers should be extremely cautious when using these materials because of their low impact strength, particularly in thin sections. In general, the low impact thermosetting materials are not advocated for aircraft use, except in a few special instances, such as instrument cases and knobs, where the danger of accidental impact is slight. They should not be used in structural applications because their impact resistance is materially lowered when they are under stress.

Parts moulded from either the high or low-impact thermosetting materials should not generally have a projected area greater than 200 square inches, or a maximum dimension greater than 20in., for the presses that will accommodate sizes bigger than this are limited in number. The majority of the thermosetting moulders use various sizes of press equipment up to approximately 600 tons and 2ft. square platens, which means that in producing a part having 200 square inches of projected area they must use pressures less than 3 tons per square inch, even in the 600-ton presses. Considering that it is often advisable to use pressures as high as 5 tons per square inch, the designer can readily realise the necessity of keeping the sizes of moulded plastic parts well within the limitations mentioned, particularly when it is remembered that a majority of the press equipment is of even smaller capacities. In utilising the high-impact thermosetting moulding materials, it should be borne in mind that these materials do not readily flow during the moulding process, and that it is therefore difficult to produce a piece having deep flanges parallel to the moulding direction, since such flanges must be filled entirely by flow of material. If such design details cannot be avoided, it is best to make such sections as thick as possible, so that the resistance to flow will be reduced to a minimum. When inserts are incorporated in such parts they should be designed so that they can be adequately supported in the mould to avoid the danger of their being distorted or displaced by the severe flow conditions. When severe flow conditions exist they can be materially reduced by the use of the transfer moulding process rather than the compression moulding process. The transfer moulding process differs from the compression moulding process in that the material is heated under pressure and reduced to maximum flow conditions in a separate chamber and is then squirted into the mould cavity where the cure is completed, whereas in the compression moulding process the entire action takes place in the mould cavity and therefore creates far greater abrasion and flowing stresses in the cavity than exist in the transfer process.

*Limitations of Thermoplastic Resin Materials.*—The transparent thermoplastic sheet stock is generally made in sheets 20in. by 50in., although in the case of the transparent acrylics, Plexiglas and Lucite, these sizes have been recently increased to approximately 50in. by 60in. When designing transparent parts these basic sheet sizes should be kept in mind, and parts should be so designed that they can be formed from flat sheets of the foregoing sizes. If larger transparent assemblies are to be made, it is necessary to design them so that they can be formed in several pieces and then assembled. This assembly can be accomplished either by the use of metal frames or by cementing the various formed sheets together, using plastic stiffening members at the joints.

A majority of the moulded thermoplastic parts is manufactured by the injection moulding process, although the compression moulding process is used to some degree. Injection moulding machines are rated by their ounce capacity, which indicates the maximum weight of the part they are capable of handling. Only a few of the moulders have machines of capacities greater than 12 oz., and a majority of the machines in operation are of still smaller capacities. Therefore in designing parts to be injection moulded from thermoplastic materials, the engineer should be careful not to exceed the capacities of the generally available equipment. The injection moulding process permits the incorporation of much more delicate inserts than can possibly be moulded by the compression moulding process, particularly in the thermosetting materials. Compression moulding of the thermoplastic materials is only used where the size of the piece is such that it cannot be handled by the injection moulding machines or where the quantities involved are so small that it would not be economic to set up an injection machine for such a short run. Most injection machines operate on a 15 to 30 second moulding cycle, and therefore they are only used where large quantities are involved. The size limitations for compression moulding of the thermoplastics are approximately the same as the size limitations for compression moulding of the thermosetting materials. Parts that are designed to be moulded from the thermoplastic materials should have sections at least $\frac{1}{8}$in. thick, but heavier sections are advisable if the part is intricate or if it is subject to low temperature impact. The size of the parts that are to be injection moulded must be designed within the space limitations of the equipment on which the moulding is to take place, and it is best in such instances for the designer to contact several possible moulders and determine what sizes can be handled on their equipment.

*Limitations of Wood Veneer Materials.*—The limitations of the flat, laminated, unimpregnated wood veneer materials—in other words, normal plywood and laminated wood—are well known and need no further comment. The limitations on formed shapes of unimpregnated wood veneer materials depend on the process used and on the equipment available. Where such formed shapes are made in hot platen presses, the maximum size limitations are usually somewhat smaller than for normal plywood sheets because of the space taken up by the forming dies. Where formed shapes are made by one of the bag-moulding processes, the size limitations depend on the dimensions of the autoclave or boiler in which the part is cured under heat and pressure. There are several autoclaves in operation of approximately 6ft. to 8ft. diameter by 20ft. in length, and some of the companies are considering installing autoclaves as large as 10ft. diameter by 40ft. in length. The bag-moulding processes therefore place little or no limitation on the size of parts, and since the pressures used in these processes are relatively low, being approximately 40 lb. to 100 lb. per square inch, wood dies may be used in many cases, particularly where small quantities are involved, without danger of distortion. Where large quantities and accurate interchangeability are required, it is best to use metal dies, but these are not necessarily expensive. In the bag-moulding process the die and the part are both in the autoclave and therefore the die is not subjected to pressure stresses such as it would be if it formed part of the surface of the pressure chamber. The die can in most cases be made as a skeleton die from sheet metal.

Wood veneer materials of any thickness from $^1/_{32}$in. upwards can be made by either process, but in applications in which there is danger of accidental impact, such as the exterior surfaces of an aeroplane, it is advisable to use material at least $^3/_{32}$in. thick. Internal parts, such as wing rib webs, may be made from thinner materials, since they are not subject to the accidental handling loads which may be imposed on exterior surfaces. When wood veneer materials are used to form part of the exterior surfaces, it is preferable to use at least five plies in their construction in order to reduce the possibilities of surface checking and fracture of the protecting finish. Three-ply plywood construction always produces a sheet that is notably stiffer in one direction than the other, and this difference tends to produce cracking or checking of the surface plies under vibratory conditions, particularly where fluctuating atmospheric conditions also exist. This difference may be greatly reduced by increasing the number of plies, resulting in a sheet having a more uniform stiffness and greater ability to withstand the effects of vibration and weather. In the fabrication of such laminated wood veneer materials it is also advisable to use relatively thin face plies, as these are less subject to surface checking than thick ones.

Since the unimpregnated wood veneer materials must be adequately protected from the weather, it is essential that the finishes be so applied that all surfaces are completely covered. In order to accomplish this result it is often necessary to use a mask when finishing parts that are subsequently to be glued, and where such masks are used they should be so designed that only a minimum amount of material is left unprotected in the final assembly. This means that the mask not only must be of the same width as the glue area it protects, but also the assembly must be accurately indexed so that the masked area corresponds exactly with the joint being glued. In many instances, applying the finish by dipping will avoid the use of masks, but when this is done the designer must be careful to provide adequate access and drainage for the finish, otherwise there will either be unfinished areas or large amounts of finish trapped in the structure. In designing assemblies to be made from wood and wood veneer materials, end-grain gluing should be avoided, for such joints cannot be relied upon to carry stresses and yet

* Paper presented at the annual meeting of the Institute of the Aeronautical Sciences, New York, January 29th, 1942.

are expensive to manufacture, since the parts must be made to such close fits in order to accomplish this type of joint. In almost all cases this type of joint can be avoided by the use of glue blocks that can be manufactured as standard parts and readily installed. In order to avoid the possibility of the workman attempting to make such end-grain joints, it is preferable to show a $\frac{1}{16}$in. clearance on the drawing, so that the parts will be definitely scant and the joints made entirely of the glue blocks. Finish should be applied to such end grain prior to assembly in all cases where it is not definitely certain that complete coverage will be obtained in final finishing.

The impregnated wood veneer materials of high density, approximately 1·4, have to date only been moulded by the hot press method, and therefore the sizes available in this material are limited to the platen sizes of the hot plate presses used or approximately a maximum size of 4ft. by 8ft. If formed parts are made from this material, the sizes will be somewhat reduced because of the space taken up by the die. The impregnated wood veneer materials of low density (approximately 0·6) may be processed in either of two ways:—(1) The veneers may be impregnated, coated with adhesive, assembled to form the laminated material, and cured and bonded in one operation in a hot press; (2) the veneers may be impregnated and cured, after which they may be assembled and bonded, using normal hot or cold-setting resin adhesives. If the first process is used, the materials can only be advantageously manufactured by the hot press method, but if the second process is used the impregnated cured veneers can be handled in a bag-moulding process in the same fashion that the unimpregnated veneers are handled. Therefore this process can be used to manufacture parts of either unimpregnated veneers or of low density impregnated veneers. The use of impregnated cured low density veneers in the bag-moulding process will eliminate many of the objections to unimpregnated wood construction from the standpoint of moisture absorption, as previously discussed.

### Tolerances

The laminated thermosetting materials can be machined to approximately the same tolerances that are used at present for metal parts, except that ground finishes cannot be produced to the same accuracy as is possible with metal. The tolerances needed in the manufacture of thermosetting and thermoplastic parts depend on the complexity of the part and on its physical dimensions. In general, a tolerance of ±0·0025in. per inch of dimension is satisfactory for dimensions that are entirely controlled by one part of the mould. If, however, a dimension is controlled by more than one part of the mould, an additional tolerance of ±0·005in. should be allowed for each mould joint line. If a dimension extends across a flash line—that is, between plunger and mould—an additional tolerance of ±0·010in. should be allowed. The above tolerances are for general moulding practice, and can in special instances be reduced to as little as 40 per cent. of the above values, but with attendant increase in die cost and rejection. Although shrinkage allowance is made in designing the mould, the foregoing tolerances are necessary in order to take care of variability between different batches of material and minor variations in moulding temperature and pressure.

In manufacturing large parts, such as pilot's enclosures from formed transparent sheet stock, the tolerances must be wider, in order to accommodate the existing methods of manufacture. In general, a tolerance of ±$\frac{1}{8}$in. should be allowed on contours and on all dimensions, except those that may be controlled by drill jigs or like fixtures. Closer tolerances may be used in local regions on such structures, but these generally require special machining operations after the part has been fabricated.

In parts manufactured from the wood veneer materials, the normal tolerances at present used in sheet metal construction will generally apply, except that the gauge of laminated wood veneer materials may vary through wider limits than are normally present in aluminium alloy sheet stock. Formed sheets of laminated wood veneer materials up to $\frac{3}{16}$in. thick can be controlled in thickness within tolerances of ±$^1/_{64}$in., but when the thickness approaches $\frac{1}{2}$in. it is best to increase the tolerance to ±$^1/_{32}$in., although closer tolerances are possible by special selection of veneer. In designing matching parts in wood veneer construction, allowance should always be made for the thickness of the finish as well as for the general tolerances, otherwise the addition of the finish may make assembly difficult.

### Applicable Specifications

The Army and Navy have issued material specifications covering laminated phenolic sheet, tube, and bar for electrical uses, moulded phenolic materials for electrical uses, transparent thermoplastic sheet, and resin-bonded aircraft plywood of the unimpregnated type, but Government specifications are not available for structural thermosetting moulded materials, for structural thermosetting laminated materials, for structural thermoplastics, or for impregnated wood veneer materials. Government specifications have been issued to cover adhesives and finishes in certain specific classes of materials, but additional specifications are necessary before this field is adequately covered.

The most urgent need at the present time is for specifications covering the structural plastic materials, particularly the moulded thermosetting plastics. If the existing specifications on electrical materials are used for structural parts, they are unduly restrictive in that the part must then be controlled for electrical properties, which entails sacrifice in the physical properties. In order to obtain the maximum electrical properties in thermosetting plastics a high resin content is required, and this reduces the mechanical strength, particularly the tension and impact strengths, materially below the values that might otherwise be attained if the resin content were adjusted for maximum strength. The Air Corps and Bureau of Aeronautics are at present co-operating on a programme to develop such structural plastic specifications, but until the new specifications are issued the aircraft manufacturers must resort to use of the specifications of the various raw material suppliers. Most of the raw material suppliers have technical data books in which they list the complete mechanical and electrical properties for each of the materials they produce. From inspection of these technical data books the aircraft manufacturer can select a group of materials which fulfils his needs. The aircraft manufacturer can then set up his own procurement specifications until such time as the Army and Navy issue specifications controlling the structural materials.

### Availability

In determining the availability of plastics and allied materials from an aircraft standpoint, not only the raw materials but also press equipment and tools and dies must be considered. Since aircraft receive top priority on plastic raw materials, and since the total volume produced exceeds by many times any possible aircraft demands, there should be no difficulty in readily obtaining adequate supplies of raw materials. As the plastic moulders and laminators have always had sufficient press equipment to absorb the entire production of the raw material suppliers, there should be ample capacity to take care of all aircraft needs. In the moulded plywood industry, particularly where the bag-moulding process is used, there is a possibility that a shortage of moulding equipment will exist if the entire aircraft industry attempts to take full advantage of moulded plywood products, but, since the equipment consists mainly of simple pressure boilers, it should not be difficult to expand the facilities in time to meet increased aircraft demands.

The development of adequate facilities for the production of tools and dies in which to manufacture the plastic parts is one of the main problems before the plastic moulders and laminators at the present time. Only a few of the plastic laminators and moulders are equipped to produce 100 per cent. of their die requirements in their own plants, by far the greatest majority relying on outside machine shops for all or part of their die requirements. These tool and die facilities were adequate for peacetime operation when manufacturers were doing a large volume production of relatively few parts, but, when it is considered that aircraft require a relatively small production of a large volume of parts, it can be readily realised that the demand for tools and dies will be greatly increased and that plastic manufacturers should therefore make every effort to increase their tool facilities to meet the changing conditions. If this is not done the aircraft industry will be restrained from taking full advantage of these materials.

### Possible Savings of Aluminium

The extensive utilisation of plastics and allied materials will also be of appreciable aid in relieving the current aluminium situation.

(1) If the aircraft industry would utilise the thermosetting plastics where practicable in secondary structural and non-structural applications, it would be possible to save up to 20,000,000 lb. of aluminium per year without jeopardising the safety of the aeroplanes by attempting to use the material in highly stressed parts or questionable applications.

(2) If the aircraft industry would utilise thermoplastic materials for all transparent enclosures and for other suitable internal parts, it would be possible to use approximately 10,000,000 lb. per year, of which up to 1,000,000 lb. might be assumed to replace aluminium alloy support frames and miscellaneous parts.

(3) If the aircraft industry would utilise the wood veneer materials for such sub-assemblies as bomb bay doors, wheel well doors, bulkhead doors, removable wing tips, table tops, cabinets, and miscellaneous equipment items, it would be possible to save up to 20,000,000 lb. of aluminium per year without attempting to extend the use of the wood veneer materials to such items as fixed tail surfaces, wing outer panels, or fuselages.

This means that a total of 41,000,000 lb. of aluminium per year could be economically saved by the use of plastics and allied materials in applications in which they are equally suitable, and in which they do not affect the overall design of the aeroplanes upon which they are used. In other words, the utilisation of plastics and allied materials would save in one year approximately six times as much aluminium as was collected throughout the entire country in the recent aluminium drive.

## British Standards Institution

*All British Standard Specifications can be obtained from the Publications Department of the Institution at 28, Victoria Street, London, S.W.1. The price of each specification is 2s. 3d. post free, unless otherwise stated.*

### STEEL TUBES FOR AIRCRAFT

Nos. 3.T.1, 3.T.2, 2.T.35, 2.T.45, and 2.T.50. During the past two or three years it has been necessary from time to time to allow a number of relaxations in the requirements of the British Standard Aircraft Specifications for Steel Tubes. The series has therefore been revised in order to co-ordinate these relaxations and to bring the specifications up to date. The principal alterations relate to the requirements with regard to the procedure in the selection of samples for test and the tolerances on tubes have also been adjusted. The technical requirements of specifications have not, however, been altered to any great extent. Price 1s. 3d. each post free.

### A.C. ARC WELDING PLANT

No. 1071. This specification has been published at the request of the Directorate of Industrial Electrical Equipment Machine Tool Control to provide A.C. welding equipment which is required for the increasing application of welding technique for shipbuilding and other similar heavy constructional work.

The equipment included in the specification is based on B.S. 638. The use of ammeters is not required, suitable scales fitted to the regulating device being used instead. A "war finish" is permitted, and when drawings are required the makers' outline drawings and diagrams of connections shall be accepted. Price 1s. 3d. post free.

# Markets, Notes and News

**The prices quoted herein relate to bulk quantities. Unless otherwise specified home trade quotations are delivered f.o.t. Export quotations are f.o.b. steamer**

### Compulsory Disclosure of Scrap Metal

The Minister of Works and Planning has made an Order (S.R. & O., 1942) (No. 1723), under which: (1) Occupiers of all premises in England, Scotland, and Wales on which there are 3 or more tons of metal suitable for scrap, must inform the Ministry of Works and Planning within thirty days of September 21st, 1942. Returns must also be made within thirty days of any subsequent day on which such an amount of metal is so accumulated; (2) metal is deemed suitable for scrap if it is any metal—ferrous or non-ferrous—other than aluminium or magnesium or their alloys, which is, or forms part of, any building, structure, plant, or article which is disused, obsolete, or redundant, or otherwise serving no useful purpose; (3) "premises," for the purpose of the Order, means any building or land which has an assessment under Schedule A, or is subject to a valuation for rating; (4) the forms to make the returns may be obtained from "Scrap Recovery," Ministry of Works and Planning, Sanctuary Buildings, Great Smith Street, London, S.W.1.

This Order is an extension of the Order (S.R. & O., 1942) (No. 761), made on May 14th, 1942, calling for an identical return from premises in the London Civil Defence Region, the counties of Essex, Dorset, Nottinghamshire, Monmouthshire, East, West and Mid Lothian, and the county boroughs of Bristol and Leeds. There are three sections to the return: Loose scrap, fixed scrap, machinery, plant, &c., and reserve or standby plant. While the Order calls for returns of machinery and plant which is disused or serving no immediate purpose, there is no intention to take as scrap valuable machinery and plant. In particular the Order does not call for a return of machinery or plant belonging to firms that have closed down under schemes of concentration approved by the Board of Trade or the Ministry of Food. No machinery or plant will be taken against the will of the owner without right of appeal and the Board of Trade will be consulted in appropriate cases before such appeals are determined. Returns are not required where: (*a*) The metal forms part of machine tools specified in the first Schedules to the Control of Machine Tools (No. 9) Order, and the Control of Machine Tools (Cutting Tools) (No. 1) Order, 1942, or in any Orders replacing or amending them; (*b*) returns have already been made to the Iron and Steel Control under the Industry (Records and Information) (No. 1) Order, 1940, or (No. 2) Order, 1941; (*c*) the metal forms part of standby plant or equipment held by public utility undertakings and which is essential for the performance of the statutory obligations of those undertakings, or which is held by them for the purposes of Sections 40, 42, 59, or 60 of the Civil Defence Act, 1939. It is the occupier of premises who has to make the return, whether or not he owns the metal. In the case of empty premises it is the person who is entitled to occupy those premises who has to make the return.

### The Pig Iron Market

The volume of business in pig iron has fluctuated somewhat of late, and after the allocations received for the fourth delivery period has been covered it is probable there will be a decline in the pressure of demand. For the time being, however, producers have enough work on hand to keep them fully employed, and in some cases contracts will have to be carried over into the fourth quarter. The characteristics of the market do not greatly vary from those which have existed for the greater part of the third period. The demand for hematite is in excess of the supply, and as a consequence there has been an important diversion of the demand to refined and low-phosphoric pig irons as substitutes. Considerable pressure is exercised to maintain the heaviest possible output of hematite, but any large increase in production is out of the question. If the demand, therefore, expands still further, consumers will have to rely to a corresponding extent upon substitutes. For some little time now the demand for low-phosphoric pig iron and refined pig irons to use instead of hematite has caused a stringency to develop in supplies of these pig irons, but the Iron and Steel Control, by careful distribution, has maintained supplies to firms engaged upon war work, and in cases in which the use of hematite was essential have managed to supply that description. The light castings foundries with few exceptions are poorly employed, and there is only a comparatively small demand for high-phosphoric pig iron, notwithstanding that this pig iron is used in a number of cases for which, previous to the war, it would have been regarded as unsuitable. The steel trade requirements of basic pig iron are abnormal, but the industry has managed to maintain full supplies. The concentration upon the production of basic pig iron has, to some extent, affected supplies for the production of other descriptions. This, however, is regarded as only a temporary difficulty and appears to have been felt chiefly by Midland producers. Generally speaking, raw materials are in ample supply, and are likely to remain so, and the country's production of pig iron should be kept at a high level.

### The Midlands and South Wales

All the finishing departments in the steel trade are fully employed, and there is a considerable accumulation of orders at the works. Nevertheless, it is only in one or two categories that there is a tendency for delivery dates to increase. The rush to meet consumers' requirements which has been almost a normal feature of the trade for so long, continues, and, in addition, work has been speeded up to complete contracts before the end of the third period. Activity now prevails at the works producing structural steel, and the demands for plates is maintained at a high rate. Heavy plates, in particular, are in strong request from the shipyards, and this is one of the branches in which the delivery dates have been somewhat extended. The volume of business passing in plates of all kinds is a feature of the market, and there seems little likelihood of the pressure relaxing for a long time, since there is a big programme of work in hand at the shipyards, while the tank makers, wagon builders, and locomotive builders are taking up considerable tonnages. Business in alloy and special steels is active, and the requirements of the armaments and aircraft manufacturers are sufficient fully to tax the resources of the producing works. In South Wales, while the iron and steel industry is fully employed, almost entirely upon Government work, the tinplate trade is an exception, and in this department quiet conditions prevail. Little export trade is carried on, as the operations of the works are restricted by Government regulations on the manufacture and consumption of tinplates. A restricted amount of business has been transacted in the home market at 29s. 9d. basis, 20×14, f.o.t. Most of the business has been in unassorted tinplates and uncoated plates, basis 25s. 9d. The demand for substitutes for tinplates, however, makes rather slow progress. The works producing billets are fully employed, and the demand is sufficiently in excess of the home production to necessitate withdrawals from stocks of imported materials.

### Scotland and the North

The activity at the Scottish iron and steel works has increased lately under pressure of demand, a great portion of which was of a high-priority character. The pressure from consumers to obtain plates is insistent, and there is a tendency for delivery dates to lengthen, although efforts are being made to check this movement. The call for plates to an increasing degree comes from the shipyards, but there is also a heavy demand for tank and boiler plates. Some relief may be afforded the Scottish works by bringing in larger supplies from other steel-producing areas. The recent improvement in demand for heavy structural steel has been maintained. There appears to have been some relaxation of the pressure to obtain the lighter descriptions. An important volume of business is passing in steel bars. Whilst there is a strong demand for the large-diameter bars, the tendency is for consumers' requirements of the smaller sizes to expand. The re-rolling mills in Scotland are fully employed, but the demand for reinforcing rods has fallen off somewhat. This section of the industry is holding good stocks of semis and is experiencing no difficulty in obtaining fresh materials where they are required. In spite of the active demand, however, some of the works are in a position to accept more business for reasonably near delivery. The munitions and armaments industries continue to call for large supplies of alloy and special steel, and, notwithstanding the pressure upon the producing works, they are meeting the requirements of consumers. To do this it has been necessary to expand production upon a considerable scale. The sheet makers in Scotland are actively employed and have big contracts on hand for Government departments. At the same time, a big outlet for sheets is provided by the aircraft makers, shipyards, and other important sections of the industry. The ironworks have experienced rather a better demand during the past month or two, and the engineering industry is taking up satisfactory tonnages. The demand is principally for small iron bars, and there is a steady call for Crown iron and best bars. The rivet, bolt, and nut manufacturers have good order books and are consuming good quantities of bar iron. In the Lancashire district all departments of the steel industry are fully employed. As in other districts, the principal call is for plates, large tonnages of which are passing into consumption. The works producing steel bars, 3in. and over, require fairly long delivery periods against new orders.

### North-East Coast and Yorkshire

Steel production on the North-East Coast has attained a very high rate and now that civilian requirements have been so drastically cut down practically the whole output is devoted to war purposes. So great, however, is the war demand that importation of semis, special steel, and finished steel has been on a somewhat larger scale of late. Most of the business which has been accepted recently has been for delivery in the fourth quarter of the year. The home production of billets, blooms, and sheet bars is almost immediately absorbed by the home trades, and complaints from the re-rolling industry of delays in the delivery of these raw materials appear to be a thing of the past. The recent improvement in the demand for constructional material, particularly of heavy joists and sections, has progressed during the past week or two, and most of the producing works have good order books. The improvement in the demand is probably due to the increased activity in the constructional engineering industry, which has received a number of important orders for Government work. There is still room for improvement in the volume of business in heavy joists and sections, but after a long spell of comparative quietness this branch of the industry now has a healthy appearance. Brief activity prevails at the Yorkshire steel works. The demand for alloy and special steels covers a wide range of specifications and most of the orders are for urgent war requirements. There is a big demand for shell steel and the works producing this material are well booked. Consumers' requirements have been fully met, although at times the sources of this branch of the industry have been severely taxed. The engineering industry is almost entirely engaged on war work and is taking up large tonnages of steel. The demand for bars for this industry has been on a heavy scale for a long time, and there is a particularly sharp request for bright-drawn steel bars. Agricultural implement makers are kept busy and have received larger allocations of steel, which should enable them to maintain their works in full employment.

### Copper, Tin, Lead, and Spelter

The non-ferrous metal position in Great Britain changes slowly, and since there is no market in the accepted meaning of the word, there are unlikely to be any marked alterations in the position during the war. On the whole, the authorities have shown considerable ability in managing non-ferrous metal trades and in dealing with the problems which from time to time have occurred. At the outset of the war the arrangements they made for supplies of non-ferrous metals have in the main worked satisfactorily and have ensured that the war industries receive their full requirements. The consumption of copper in Great Britain has reached enormous proportions and appears to be further expanding. The use of brass in the production of munitions is growing and the brassmakers are amongst the largest consumers of copper, although large tonnages are also going into use with the production of many types of munitions. The demand for brass rods is active, but the Control is carefully supervising the distribution of all descriptions of brass and copper. . . . The tin situation appears to be well in hand, in spite of the difficulties which have arisen as a result of the loss of the Far Eastern sources of supply. Continual efforts are being made to reduce the consumption of the metal, and this week an Order (No. 8), controlling the use of tins, tin cans, kegs, &c., for packing, has been issued. An official announcement made in Canada states that the consumption of tin is 40 per cent. below the pre-war standard and the civilian consumption down by 75 per cent. Production of tin in countries outside Axis control has also been pressed to the utmost. . . . All applications for licences for lead are closely scrutinised by the Control, but full supplies are reaching firms engaged upon war work. Supplies of lead appear to be reaching this country with regularity, but it is obvious that the Control has to watch the position carefully in view of possible war developments. . . . There has been no development of importance in the spelter situation for a long time. The position has been stringent, but the requirements of the war industries have been met. There has, however, been no zinc available for ordinary commercial purposes. The position is continually under review and wherever possible attempts are made to reduce the use of the metal.

# Notes and Memoranda

## Rail and Road

FREE FOOD FOR LIVESTOCK.—Grass on L.M.S. Railway embankments is offered free to farmers and adjoining owners who take it at their own cost. Over a thousand people have availed themselves of the facility in the last year.

A ROAD TO AN OILFIELD.—A comparatively recent discovery of crude oil in the Ram River area of British Columbia may necessitate the construction of an all-weather road from Rocky Mountain House to the site. The distance is 40 miles in a direct line and through unbroken country.

L.M.S. ACTING C.M.E.—The L.M.S. Railway announces that Mr. C. E. Fairburn has been appointed acting chief mechanical engineer in the absence of Mr. W. A. Stanier, who has been seconded to the Ministry of Production on special duties. Mr. Fairburn's headquarters will be at Nelson Street, Derby.

SHORTENING THE ROUTE.—The Lake Erie South Road from Detroit to Buffalo is 375 miles. By using Ontario highways, United States lorries carrying war materials between the two cities can save over 100 miles. Permission has been granted by the Dominion Government for the licensing of U.S. lorries to transport war materials in bond for the duration of the war only on this route.

THE SPURRIER MEMORIAL TRUST.—At an informal meeting of the Institute of Transport, on September 15th, Mr. E. S. Shrapnell-Smith, on behalf of the Henry Spurrier Memorial Appeal Committee, handed to the President, Mr. J. S. Nicholl, the deed entrusting to the Institute the administration of the fund for the establishment of Henry Spurrier Memorial Scholarships and Henry Spurrier Memorial Lectures. Mr. Shrapnell-Smith paid tribute to the great qualities of the late Mr. Spurrier and to his work in the development of commercial road transport. The sum of £10,000 had already been passed to the Institute, and it was thought that the total of the fund might reach £15,000.

SOUTHERN RAILWAY AND PAPER SALVAGE.—In co-operation with the Waste Paper Recovery Association, the Southern Railway is contributing to the national campaign to save paper for munitions of war. Tickets are now being printed 39 to the inch in bulk, as compared with 32 to the inch in bulk in pre-war days, and this leads to a saving of 500 tons of paper a year. Stamp headed rough paper cut from old posters is used for internal correspondence and train time sheets. Office note pads are made up of cut-up posters, and multiple-use envelopes are now used, enabling four journeys to be made, and also old envelopes to be used many times with a gummed slip pasted over the original address. All the Southern Railway bill-boards have the old bills stripped from them regularly and the scrapings are put into special bins for salvage. In peacetime two types of staff privilege ticket forms were used, one for local travel and the other for use on the lines of other companies. These have now been standardised on one form and the size reduced. Waste paper from offices and departments sent to waste paper depôts in 1939 was 665 tons, in 1940 1160 tons, and in 1941 1200 tons, whilst in each of 1940 and 1941 the company reclaimed 100 tons for further office use in other ways.

## Air and Water

SHIP REPAIRS IN CANADA.—A ship repairing wharf is to be erected on the city side of Courtney Bay at St. John, N.B., by the Federal Department of Public Works.

TO BE REBUILT.—What are known as the Midland Boat Works of Ontario were recently destroyed by a fire, and with a loss estimated at 1,000,000 dollars. They are to be rebuilt immediately.

COLLAPSE OF A SUSPENSION BRIDGE.—A comparatively short suspension bridge across Riviere de Prairie recently collapsed, plunging twenty-five persons into the water. No one was seriously injured. The bridge connected the island of Montreal with Vanier beach, north of the city.

NEW YORK TO FOYNES AIR SERVICE.—*The Aeroplane* has recorded that non-stop services from New York to Foynes are now being operated twice a week by American Export Air Lines. In the reverse direction a stop is made at Botwood. The time for the non-stop service is frequently between fourteen and fifteen hours with a pay load of about 4000 lb., and on the east to west crossing some 800 lb. more pay load is carried. The service carries passengers, mails, and freight in both directions, sixteen passengers on each flight. The three Vought-Sikorsky "VS-44A" flying boats of American Export are giving excellent service and passengers speak well of their comfort. Only one, the "Excalibur," has been named as yet, but the other two, like the "Excalibur," are to be named after the ships of American Export Lines, the parent shipping company of American Export Air Lines. A crew of ten is carried on the "VS-44A," and the company has twelve fully trained crews. Three return survey flights were made over the Atlantic route before the regular services were started and some thirty flights have been made on the regular schedules.

RELIC OF THE "ROYAL CHARTER."—Part of the sternpost of an historic wreck has been given to the Ministry of Works team now combing Wales for scrap metal. It comes from the "Royal Charter," which, homeward bound on its maiden voyage from Australia in 1859 with 427 people aboard and £500,000 worth of gold coins and bullion, was wrecked near Moelfre, Anglesey—almost within sight of her home port of Liverpool. In the hurricane that raged all night, the ship's anchors parted and she was dashed on the rocks. The force of the waves split her in half and practically all on board perished. Her bullion room was shattered, and for many years after gold coin and bullion were salvaged on the bleak Anglesey coast. The sternpost will now go to the war foundries. It has been given for scrap to the Ministry of Works by Major C. E. Irby, brother of Lord Boston and heir to the Boston estates, on which land the post was deposited in 1897, when, with 580 sovereigns and gold dust still lying in a rough trough formed by the attached stern plates, it was first salvaged from the sea.

## Miscellanea

TIN IN SOUTH AFRICA.—The Minister of Mines for S.A. reports the discovery of tin deposits in South-West Africa, which appear highly promising, both in extent and richness of ore. The question of working is the subject of negotiations between the Union Government and the South-West Africa Administration.

EDUCATION BY THE FILM.—Faced with the task of hiring 6000 employees to man its new war plant, the Allis-Chalmers Manufacturing Company, of America, has evolved a plan for introducing new employees, many of whom have never before been inside an industrial plant, to the company, its policies, its products, and the conditions under which they will work. The scheme makes use of moving pictures shown at sessions, which often last three hours, those present being paid full wages for the time spent at the meeting. The film is followed by a discussion of the work to be performed by the new employees.

FUEL EFFICIENCY CAMPAIGN.—In connection with the Ministry of Fuel and Power's efficiency campaign, a Fuel Economy Committee has been formed in Hampshire, the area covered being that part of Hampshire east of Lymington River and including Midhurst and Chichester. The object of the Committee is to ensure the efficient use of fuel, heat, and power in industrial undertakings, and it will be assisted by a panel of engineers, who will make inspections of plant and submit recommendations for the more efficient working of the plant. The Chairman is Dr. W. G. Green, of the Engineering Department, Portsmouth Municipal College, and the Honorary Secretary is Mr. E. C. Rogers, of Quay House, Broad Street, Portsmouth.

STANDARD SCHEDULE OF PRICES.—A supplement to the Standard Schedule of Prices of the Ministry of Works and Planning has been prepared by the Technical Sub-Committee of the Central Council for Works and Buildings and is now on sale at H.M. Stationery Office, price 4d., post free. This supplement contains prices for approximately 150 additional items of work which have been found necessary for the type of work for which the Ministry have used the Schedule. In particular, there is a more complete schedule for prefabricated hutments; and schedules for special lightweight steel tubing for water services, for camouflage painting and for asbestos cement pressure pipes for water mains; there are also prices for various additional items in most of the trades.

## Personal and Business

MR. GEORGE BRIGGS has been appointed Deputy Controller, Iron and Steel Control, Ministry of Supply.

MR. H. J. ALLCOCK, M.Sc., M.I.E.E., M.I. Mech.E., production officer and former process manager of Callender's Cable and Construction Company, Ltd., has been appointed Director-General of Communications Equipment in the Ministry of Aircraft Production.

THE INSTITUTE OF FUEL has announced the award of the Melchett Medal for 1942 to Dr. Arno Carl Fieldner, Chief of Fuels and Explosives Services, United States Bureau of Mines.

MR. F. H. WYNNE has retired from the post of H.M. Chief Inspector of Mines, on reaching the age limit. He is to be succeeded by Mr. J. R. Felton, who has been the Deputy Chief Inspector since the end of 1937.

THE LORD PRESIDENT OF THE COUNCIL has appointed Sir Lawrence Bragg, D.Sc., F.R.S., Professor J. E. Lennard-Jones, Ph.D., D.Sc., F.R.S., Mr. A. McCance, D.Sc., and Sir Raymond Streat, C.B.E., to be members of the Advisory Council to the Committee of the Privy Council for Scientific and Industrial Research from October 1st, 1942. Dr. G. M. B. Dobson and Mr. S. K. Thornley will retire from the Council on completion of their terms of office on September 30th.

## Forthcoming Engagements

*Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the* TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

### Institute of Fuel

*Tuesday, Oct. 13th.*—Inst. of Electrical Engineers, Savoy Place, Victoria Embankment, W.C.2. Presidential Address, W. M. Selvey. 2.30 p.m.

### Institution of Automobile Engineers

*Sunday, Oct. 11th.*—LONDON GRADUATES: 12, Hobart Place, S.W.1. "A Post-war Motor Vehicle," L. H. Hounsfield. 3 p.m.

### Institution of Chemical Engineers

*Tuesday, Oct. 13th.*—Geological Society's Rooms, Burlington House, Piccadilly, W.1. "The Production of Radium," E. F. MacTaggart. 2.30 p.m.

### Institution of Electrical Engineers

*Saturday, Sept. 26th.*—N.E. STUDENTS' SECTION: Visit to A. Reyrolle and Co., Ltd.

*Thursday, Oct. 1st.*—Savoy Place, Victoria Embankment, W.C.2. Presidential Address, Professor C. L. Fortescue. 5.30 p.m.

*Wednesday, Oct. 7th.*—WIRELESS SECTION: Savoy Place, Victoria Embankment, W.C.2. Chairman's Address, R. L. Smith-Rose. 5.30 p.m.

*Wednesday, Oct. 14th.*—TRANSMISSION SECTION: Savoy Place, Victoria Embankment, W.C.2. Chairman's Address, P. E. Rycroft. 5.30 p.m.

*Thursday, Oct. 15th.*—INSTALLATIONS SECTION: Savoy Place, Victoria Embankment, W.C.2. Chairman's Address, R. Grierson. 5.30 p.m.

### Institution of Engineers and Shipbuilders in Scotland

*Tuesday, Oct. 20th.*—39, Elmbank Crescent, Glasgow Presidential Address, F. C. Stewart. 6.30 p.m.

### Institution of Mechanical Engineers

*Monday, Oct. 5th.*—SCOTTISH BRANCH: Royal Technics College, Glasgow. "Poison Gases," Professor W. M. Cumming; and "Physiological Effects and Treatment," Dr. A. Goodall. 7.30 p.m.

*Friday, Oct. 9th.*—Storey's Gate, Westminster, S.W.1. "The Training Activities of the Ministry of Labour," E. Watson Smyth. (Informal meeting.) 5.30 p.m. —SCOTTISH GRADUATES' SECTION: Royal Technical College, Glasgow. "Wartime Effects on Engineer and Patent Law," R. W. Cunningham. 7.30 p.m.

*Thursday, Oct. 15th.*—MIDLAND BRANCH: James Watt Memorial Institute, Birmingham. "Fencing of Machinery," H. A. Hepburn. 5.30 p.m.

### Institution of Production Engineers

*Saturday, Oct. 10th.*—YORKSHIRE SECTION: The University, Leeds. "High Speed in the Production Shop," Dr. G. Schlesinger. 2.30 p.m.

*Saturday, Oct. 17th.*—MANCHESTER SECTION: Houldsworth Hall, Manchester. "Some Post-war Industrial Problems," Dr. A. P. M. Fleming. 2.30 p.m.

### Iron and Steel Institute

*Wednesday, Sept. 30th.*—Engineers' Club, Albert Square, Manchester. "The Work-hardening and Ageing of Steel," Professor J. H. Andrew and Dr. H. Lee. 6.30 p.m.

### Junior Institution of Engineers

*To-day, Sept. 25th.*—39, Victoria Street, S.W.1. "My Place in the Institution," R. Lowe. 6 p.m.

*Friday, Oct. 9th.*—39, Victoria Street, S.W.1. "Sinking and Erection of Cast Iron Tubbings," H. A. Hatt. 6 p.m.

### Manchester Association of Engineers

*Saturday, Sept. 26th.*—Engineers' Club, Albert Square, Manchester. Presidential Address, H. L. Butterworth. 2.30 p.m.

*Saturday, Oct. 10th.*—Engineers' Club, Albert Square, Manchester. "Plastics and their Application to Engineering," J. Prior. 2.30 p.m.

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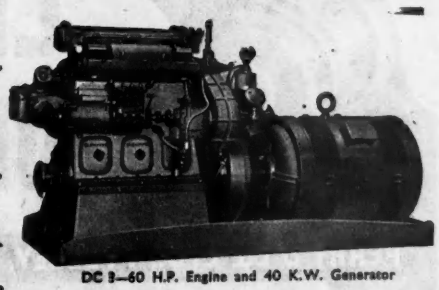
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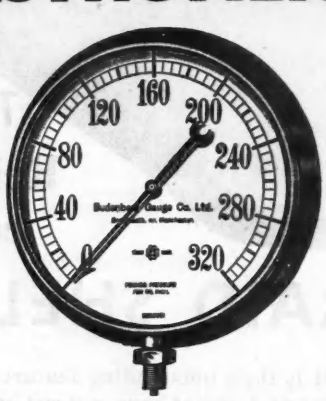


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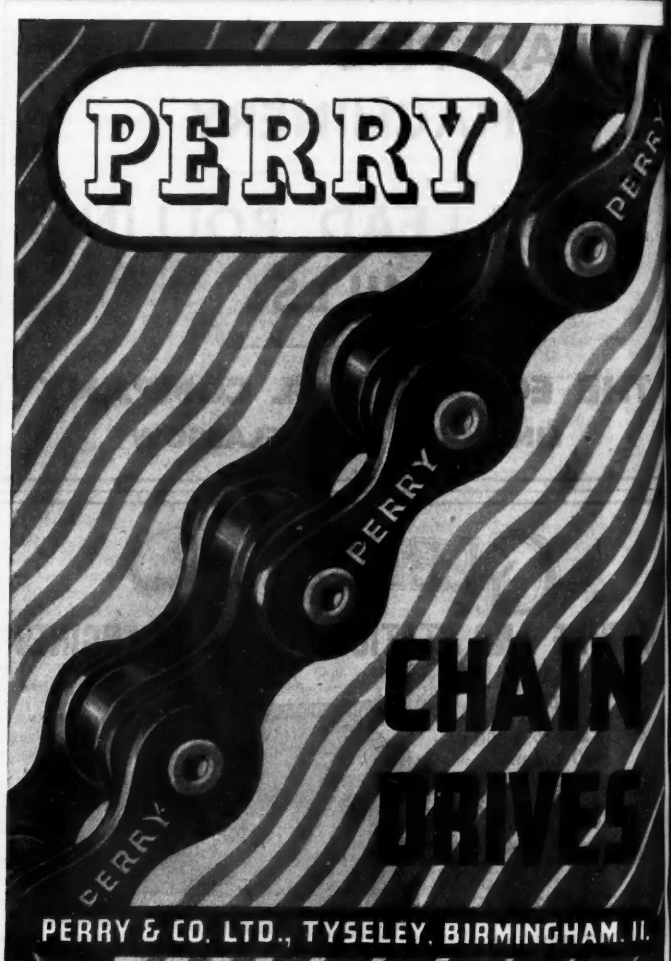


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